NATURE

No. 4389 SATURDAY, DECEMBER 12, 1953 Vol. 172

CONTENTS

	Page
National Sovereignty, the Continental Shelf and Marine Research	1063
The Petroleum Industry. By Lieut.-Col. S. J. M. Auld, O.B.E.	1065
Sex Hormones and Cancer. By Prof. W. S. Bullough	1066
Production and Uses of Glycerine. By Prof. T. P. Hilditch, C.B.E., F.R.S.	1066
Aspects of Modern Metallurgy. By Prof. F. C. Thompson	1067
Inorganic Chemistry for the General Student. By Dr. D. S. Payne	1068
The Continental Shelf	1070
XIX International Physiological Congress, Montreal. By Dr. W. L. M. Perry	1071
The Armament Research Establishment	1075
Obituaries:	
Prof. T. Thunberg. By Prof. F. G. Young, F.R.S.	1079
Mr. L. St. L. Pendred, C.B.E. By Eng.-Capt. Edgar C. Smith, O.B.E.	1079
Mr. A. B. Broughton-Edge, M.B.E.	1080
Mr. Robert Donaldson. By Dr. L. A. Sayce	1080
News and Views	1081
Institute of Personnel Management. By T. H. Hawkins	1086
The Craftsman in the Engineering Industries. By D. B. Welbourn	1088
Forecasting Weather from Solar Radiation. By Dr. C. E. P. Brooks	1089
Federal Forest Administration in Malaya: Annual Report for 1951. By Prof. E. P. Stebbing	1090
Tertiary Floras	1090
Register of Research in the Social Sciences	1091
Distribution of the Brush Possum in Tasmania. By Dr. Eric R. Guiler	1091
Aminolævulinic Acid and Porphyrin Biosynthesis. By Dr. A. Neuberger, F.R.S. and J. J. Scott	1093
Biological Systems and the Principle of Minimum Entropy Production. By Dr D. C. Spanner	1094
Letters to the Editors:	
Terminology of Enzyme Formation.—M. Cohn, Dr. J. Monod, M. R. Pollock, S. Spiegelman and R. Y. Stanier	1096
Nomenclature of *cyclo*Hexane Bonds.—Prof. D. H. R. Barton, Prof. O. Hassel, Prof. K. S. Pitzer and Prof. V. Prelog	1096
Determination of Dry Mass, Thickness, Solid and Water Concentration in Living Cells.—Dr. R. Barer	1097
Origin of the Pituitary Body of Chordates.—David B. Carlisle	1098
Premature Oviposition in the Hen.—A. H. Sykes	1098
Thermal Contraction of Collagen and its Dissolution with Elastase.—Dr. I. Banga; Dr. D. A. Hall, Prof. R. E. Tunbridge and G. C. Wood	1099
'Multiple Dipping' Procedures in Paper Chromatography: a Specific Test for Hydroxy-proline.—Dr. John B. Jepson and Ivor Smith	1100
Effect of Surface Films on Evaporation of Water.—W. W. Mansfield	1101
Analytical Separation of the Methyl Esters of the C_{12}–C_{22} Fatty Acids by Vapour-Phase Chromatography—F. R. Cropper and A. Heywood	1101
A Simple Chromatographic Method for the Determination of the C_{10}–C_{20} Saturated Straight-Chain Fatty Acids.—H. J. Nijkamp	1102
The $^{54}Fe(n,p)^{54}Mn$ Reaction.—G. H. Stafford and L. H. Stein	1103
Interstitial Atoms in the Layer Structure $ZnMn_2O_3.3H_2O$ (Chalcophanite).—A. D. Wadsley	1103
Influence of some Impurities, notably Potassium, upon the Reactivity of Iodine Pentoxide towards Carbon Monoxide.—E. G. Adams and N. T. Simmons	1104
Use of High Contrast in the Photography of Interference Fringes.—J. M. Hough and B. J. Goldsmith	1105
Dielectric Properties of Nitrocellulose–Water Gels.—Dr. Hugo Fricke	1106
Budding of Erythrocytes in the South African Clawed Toad (*Xenopus laevis*) after Splenectomy.—Marcus Jacobson	1107
Hatching the Contents of Cysts of *Heterodera rostochiensis* with Alternating Temperature Conditions.—Daphne D. Bishop	1108
Rate of Activity as a Function of Intertidal Height within Populations of some Littoral Molluscs.—Earl Segal, K. Pampapathi Rao and Thomas W. James	1108
Feeding Mechanism of an Ephemeropteran Nymph.—R. Hartland-Rowe	1109
Chemical Examination of the Piltdown Implements.—Dr. K. P. Oakley and J. S. Weiner	1110

NATIONAL SOVEREIGNTY, THE CONTINENTAL SHELF AND MARINE RESEARCH

MARINE biologists and oceanographers have greatly benefited by the legal doctrine of the freedom of the seas. In times of peace they have been able to work wherever scientific needs dictated. However, since 1945 there has been a flow of unilateral declarations concerning sovereignty over the continental shelf, which boded ill for the future of international marine research in the areas concerned. The proclamations have arisen mainly from the urge to obtain oil from beneath the shelf. The International Law Commission of the United Nations has now considered, at great length, the regime of the high seas, and has agreed to recognize qualified sovereign rights of a coastal State over the adjacent part of the continental shelf as far as the 200-metre contour. The implications are far-reaching. The Commission's recommendations should be carefully examined before they come up for consideration by the General Assembly.

The position was ably stated by Dr. A. E. Moodie, of the Department of Geography, Birkbeck College, London, at a joint meeting of Sections C (Geology), D (Zoology) and E (Geography) of the British Association during the recent Liverpool meeting, an account of which appears on p. 1070, together with later information on the subject. All waters contiguous to a coast will be divided into two zones. First is the 'territorial sea', replacing the older 'territorial waters' lying between low-water mark and the three-mile (or *x*-mile) limit; within it full sovereign rights will be exercisable. The territorial sea will not be further discussed here. But secondly, there is the continental shelf, legally extending from the limit of the territorial sea to the 100-fm. or 200-m. contour at the edge of the shelf

The recommendations are presented as a series of eight draft articles in the "Report of the International Law Commission covering the Work of its Fifth Session" (United Nations: General Assembly, Publication *A/CN.4/76*, August 17, 1953). They are:

(1) As used in these articles, the term 'continental shelf' refers to the sea-bed and subsoil of the submarine areas contiguous to the coast, but outside the area of the territorial sea, to a depth of two hundred metres.

(2) The coastal State exercises over the continental shelf sovereign rights for the purpose of exploring and exploiting its natural resources.

(3) The rights of the coastal State over the continental shelf do not affect the legal status of the superjacent waters as high seas.

(4) The rights of the coastal State over the continental shelf do not affect the legal status of the airspace above the superjacent waters.

(5) Subject to its right to take reasonable measures for the exploration of the continental shelf and the exploitation of its natural resources, the coastal State may not prevent the establishment or maintenance of submarine cables.

(6) (*a*) The exploration of the continental shelf and the exploitation of its natural resources must not result in any unjustifiable interference with navigation, fishing or fish production.

(*b*) Subject to the provisions of paragraphs *a* and *c* . . . the coastal State is entitled to construct and maintain on the continental shelf installations necessary for the exploration and exploitation of its natural resources and to establish safety zones at a reasonable distance around such installations and to take in those zones measures necessary for their protection.

(*c*) Such installations, though under the jurisdiction of the coastal State, do not possess the status of islands. They have no territorial sea of their own and their presence does not affect the delimitation of the territorial sea of the coastal State.

(*d*) Due notice must be given of any such installations constructed, and due means of warning of the presence of such installations must be maintained.

(*e*) Neither the installations themselves nor the said safety zones around them may be established in narrow channels or on recognized sea lanes essential to international navigation.

(7) (*a*) Where the same continental shelf is contiguous to the territories of two or more States whose coasts are opposite to each other, the boundary of the continental shelf appertaining to such States is, in the absence of agreement between those States or unless another boundary line is justified by special circumstances, the median line every point of which is equidistant from the base lines from which the width of the territorial sea of each country is measured.

(*b*) Where the same continental shelf is contiguous to the territories of two adjacent States, the boundary of the continental shelf appertaining to such States is, in the absence of agreement between those States or unless another boundary line is justified by special circumstances, determined by application of the principle of equidistance from the base lines from which the width of the territorial sea of each of the two countries is measured.

(8) Any disputes which may arise between States concerning the interpretation or application of these articles should be submitted to arbitration at the request of any of the parties.

The construction of the boundaries between areas of national sovereignty over the sea bed is likely to be contentious. Applying Article 7, par. *a* to the North Sea, it would seem that the whole of its bed would become divided between Denmark, Germany, Holland, Belgium, France and the United Kingdom. However, the Norwegian Government presented a case which is accommodated by par. 66 of the Report. It remains open to Norway to protest that the existence of the Norwegian Channel, deeper than 200 m. and close to the Norwegian coast, is no hindrance to the claim of Norway to sovereignty over the shelf as far west as the median line which would be drawn if the Channel was not there.

Many conflicting views were expressed at the sittings of the Commission as to national rights to exploit fisheries and oil on or beneath the sea bed; but there has been little if any mention of rights of fundamental research by ships of one nation in areas of the continental shelf under the sovereign jurisdiction of another. Marine research workers would be wise to clarify for themselves what rights of scientific exploration they need, to decide whether these are in danger and, if they appear to be so, to represent through their national governments to the Commission or the General Assembly what amendments are needed to enable fundamental research at sea to proceed as freely in the future as in the past.

Under Article 3 it would seem that the work of the physical oceanographer or marine biologist on the waters over the shelf should nowhere be impeded. The coastal State can have no right to prevent the taking of water samples, the making of physical measurements or the working of pelagic nets in superjacent waters.

Scientific investigation of the surface of the sea bed with instruments, such as the trawl, would seem to rank with commercial demersal fishing. It is clearly understood that the rights of a coastal State do not cover so-called bottom fish and other fish which, although living in the superjacent water, occasionally have their habitat next to the bottom or are bred there.

The Commission held long discussions on the sedentary fisheries, such as that for the oyster. Disagreement between the jurists was radical and no firm agreement could be reached. The Commission has apparently concluded that the products of certain fisheries, particularly those for sedentary organisms permanently attached to the bed of the sea, should not be outside the regime of the coastal State.

If this opinion is accepted by the General Assembly, a coastal State would appear to acquire the right to prohibit any scientific investigation by a foreign ship of the zoology, geology or geophysics of the bed or 'subsoil' of the continental shelf under its jurisdiction. In the present temper of international relations—which oil in bulk appears not to lubricate—embargoes by coastal States on research appear a very real risk.

If the draft articles of the International Law Commission are accepted by the General Assembly of the United Nations and become the law of the high seas, it will be too late for institutions of marine research to complain that the law is not to their liking. Now is the time to establish that fundamental research by one nation is in the interests of all, and to ensure that the drafting is so amended as to permit fundamental research at sea to proceed without vexatious obstruction.

The Commission mentions "the possibility of creating an international agency charged with scientific research and guidance with the view to promoting, in the general interest, the most efficient use of submarine areas. It is possible that some such body may be set up within the framework of an existing international organization". The stress is not on unfettered, fundamental research, but on directed, 'useful', development work. Creation

of yet another *ad hoc* body is to be deprecated. Already there exist the International Council for the Exploration of the (Western European) Sea and similar bodies in other areas; together with the International Unions of Geodesy and Geophysics and of Biological Sciences, the Association of Physical Oceanography and the Joint Commission on Oceanography, which are interlocked. There is every reason for using one or more of these bodies to guide the International Law Commission on scientific problems and to help to administer any machinery of registration and direction which may be forced upon the marine scientific community.

Initiative can be taken only by a representative national group of oceanographers and marine biologists, who would require first to decide whether the proposed developments of international law do indeed carry a threat to the freedom of marine research. If in Great Britain this should be agreed, the group would need to advise the Government on measures it could submit to the United Nations to ensure freedom of scientific research at sea; and it would at all stages need legal advice. Possibly the Royal Society would be the appropriate body to take effective initiative; the matter is clearly one of urgency, for it will take time for the various bodies interested to formulate their views and agree on a course of action.

THE PETROLEUM INDUSTRY

The Science of Petroleum

Vol. 5, Part 2: Synthetic Products of Petroleum. Edited by Dr. B. T. Brooks and Dr. A. E. Dunstan. Pp. x+330+31 plates. (London, New York and Toronto: Oxford University Press, 1953.) 100*s*. net.

IT seems appropriate that this addendum to "The Science of Petroleum" should have as its sole editors B. T. Brooks and A. E. Dunstan, to whom the inception of the whole work was mainly due. Both played a leading part in the development of present-day petroleum technology, and both were men of vision and the determination to turn their dreams into large-scale reality. Were they chemical engineers? Well, maybe. Brooks describes himself as such in his review of the production of other chemicals from petroleum hydrocarbons. But the volume is chiefly a justification by works of the organic chemist who has harnessed his fellow scientific workers and the engineer to his needs, yet has shown himself to be both an able scientist and an excellent technical director. Thought and faith are, indeed, mightier things than time can wrong, and even the modest editorial preface, and the foreword by a great leader of the oil industry, cannot obscure the achievements of the organic chemist in shaping the destinies of petroleum to their present impressive purposes.

Like its predecessors the supplement is a wise collection of contributions by leading specialists, sufficiently overlapped where necessary to cover the broad (and deep) sections into which the subject-matter falls. Like other treatises it was no doubt 'dated' as soon as written; but it is not thereby out of date. No work can be which is fundamentally treated, and this is certainly the case here. One may regret the absence of climax wrought or progress made since the initial publication; but the fact is that, with the basis well treated, additional material in most cases can be quickly absorbed from current literature. The editors and contributors are to be congratulated on providing unexceptionable material which will continue to be a reference however much new discovery is made. This is well seen, for example, in Section 1, which deals with synthetic products. The contributions on hydrocarbon polymerization lead from a general treatment through the special cases of the olefines and isobutylene polymers and co-polymers to butadiene, isoprene and styrene as raw materials for synthetic rubbers. All are of a high standard, and the article on chemicals for synthetic rubbers will certainly be used for reference for a long time.

The effect is not so well marked in the provision of only a single article devoted to surface-active agents, possibly because much had already been written on this subject prior to the use of petroleum as a raw material. Yet the domestic and industrial use of detergents, wetting agents, emulsifiers, and so on, derived from petroleum already comprises an industry, within the main industry, which is continuously expanding. It might therefore have been considered worthy of more extensive treatment than it has been accorded.

Section 2 is concerned wholly with refinery processes and starts off with a series of articles on fractionation. This is first-class material and is concerned with the fundamentals of design and methods of application. It gives a clear insight into the principles of refinery design. Something more might perhaps have been included on the details of heat transference as demanded by the less conventional conditions of heat exchange, and the same might be said of plate hydraulics and column design.

Attention will be chiefly focused on the parts dealing with the practical problems of hydrocarbon re-structure. That of chief interest is, of course, catalytic cracking, which started on a somewhat empirical basis and then rapidly moved into the field of calculation based on observational and theoretical considerations. Fixed bed, fluid technique and air-lift were all the results of the insatiable wartime demand for high-octane gasoline. All were worked out with finest regard to fundamentals as well as to the use of great changes in chemical engineering method. The five articles dealing with cracking will probably for all time best summarize the state of the art during the wartime decade. But it is significant that there they stop, there being scarcely a reference to work subsequent to 1947. It has already been pointed out that, in the publication of a compendium, such gaps are bound to exist, but it happens in this particular case that an important step has been taken during the interval: namely, the development of conjoint catalytic cracking, directive hydrogenation of olefines, and dehydrogenation of naphthenes, so as to produce the kind of gasoline wanted, and at the same time meet the ever-growing demand for the aromatics needed as intermediates by the synthetic fibre and plastics industries. This achievement has resulted largely from the discovery and use of special platinum catalysts, and it is a type of process which appears to be altering refinery practice profoundly and deserves close attention. With coal tar being rapidly ousted from its premier position as the source

of the simpler aromatics, and the world demand for such aromatics being still unsatisfied, it is to be hoped that issue of the forthcoming Part 3 of Vol. 5 will be hastened and will meet the need for authoritative descriptive matter on the subject. It would be a good occasion also to show more clearly the dependence upon petroleum of the plastics and synthetic fibres industries which are taking such a big place in the modern world.

The book finishes with three articles on alkylation, the first being by its British co-originator and protagonist. These are permanent records but it is doubtful, with the disappearance of the internal-combustion engine from high-speed aircraft, whether alkylation will retain its past importance.

The volume is prepared with the same splendid care as those previously issued. It should be on the bookshelf of every student of petroleum from undergraduate and cadet to executive and director.

S. J. M. Auld

SEX HORMONES AND CANCER

Oestrogens and Neoplasia

By Harold Burrows and Eric S. Horning; with contributions by W. C. J. Ross and C. W. Shoppee. Pp. xv+189. (Oxford: Blackwell Scientific Publications, Ltd., 1952.) 30*s*. net.

IN the words of a preface, written by Dr. Charles Huggins, this book is indeed "a chronicle of great events in cancer research", and to this it may be added that the chronicle is itself an excellent one. It is a comprehensive review of present-day evidence concerning the relations between the œstrogenic hormones and cancer, and for many years to come the long reference list will remain an invaluable tool in the hands of those entering this field of research.

The book begins with a brief but excellent description of the chemistry of the best-known œstrogenic substances, both natural and synthetic, together with much information regarding weak or non-œstrogenic substances. This leads to an account of the occurrence and metabolism of these compounds, an account which is expanded and enlarged from a physiological point of view in the second chapter. Thence the argument passes to a particularly interesting review of the influence of œstrogens on tissue growth, the tissues considered being not only those which are related to the sex function, but also those of the general body. The relation between excessive mitotic activity and cancer incidence is explored in a convincing manner, although, since the book went to press, there is some fresh evidence which suggests that this relationship may not be quite so straightforward as the present account might appear to indicate.

The remainder of the book is taken up with a detailed statement of evidence supporting the important conclusion that the œstrogenic hormones are to be regarded as essential agents in the causation of several kinds of cancer, although, of course, it is fully realized that they are unable to exert this effect unless their action is accompanied by that of certain other factors and conditions. Important in this connexion may be viruses, differences between species, hereditary differences within species, rate of food intake and so on. Considerable space is devoted to detailed accounts of tumours of the hypophysis, of the ovary, the uterus and the mammary gland, of the testis and the prostate, of the adrenal, and of several other tissues. Finally, there is also a chapter on the prospects of chemotherapy which, however, on present evidence are considered to be poor.

There are two features of the book which call for special praise. The first is the manner in which it is repeatedly stressed that basic research is of primary importance to an understanding of the problem of cancer and to the development of new techniques for treatment. A clear knowledge of the physiology and chemistry of normal growth is undoubtedly an essential prerequisite for an understanding of abnormal growth, and academic research to this end should be actively fostered. This obvious fact is commonly overlooked. The second unusual feature is the pleasure with which the book can be read. The arguments are always clearly and logically stated, and nowhere does the story degenerate into an undigested catalogue of conflicting facts, as is the case with so many books of its kind. From all points of view it can be highly recommended.

W. S. Bullough

PRODUCTION AND USES OF GLYCERINE

Glycerol

Edited by Carl S. Miner and N. N. Dalton. (American Chemical Society, Monograph Series No. 117.) Pp. xiv+460. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 96*s*. net.

THE appearance of a most comprehensive treatise on glycerol, its sources, production, properties and uses, brings to mind the very large consumption of glycerine at the present time, and its wide range of uses. 'Glycerol'—the accepted chemical name given to the trihydric alcohol $C_3H_5(OH)_3$ by Chevreul (in virtue of its sweet taste)—and 'glycerine' are synonymous terms: it is useful, as the editors of the monograph agree, to retain both, employing 'glycerol' to designate it as a chemical entity and in considering its physical and chemical attributes, and leaving the long-used 'glycerine' in reference to its industrial forms and uses.

The annual world production of glycerine was estimated to be about 75,000 tons at the beginning of the century, and about 170,000 tons in 1939, while in 1950 it had reached more than 220,000 tons. For many years the United States has contributed about half the total production, while Great Britain has produced 15–20 per cent. The chief outlets for industrial glycerine may seem surprising: in the United States the largest use—nearly 30 per cent of the U.S. production—was in the manufacture of alkyd resins for paints and varnishes. Explosives, tobacco and cigarette manufacture, cosmetics with pharmaceutical preparations, and transparent cellulose tissue manufacture each absorbed 10–12 per cent, and the remaining 25 per cent was divided among a number of manufactures, including corks, printing inks, foods and beverages, textiles and adhesives. The proportions of glycerine used by different industries will be materially different in some instances in Great Britain, but the figures given by Miner and Dalton serve to indicate the general picture. The authors,

indeed, ascribe to glycerine in the United States the position given by a Victorian statesman to sulphuric acid in England—an index of industrial production and the state of trade at large.

Until quite recently the only industrial source of glycerol was from fats and oils, as a secondary product in the manufacture of soap. Consequently, when sudden changes in demand arose—as for explosives in the First and Second World Wars, or when the new industry of alkyd resin manufacture developed on a large scale—glycerine supplies were temporarily inadequate and extreme fluctuations in price were liable to take place. During the First World War, processes were developed for producing glycerol in industrial quantities by modified yeast fermentation of sugar; but these did not compete with fat glycerine when the latter again became freely available in the inter-war years. Very recently, however, after many years research it has become possible to manufacture glycerol from propylene, a hydrocarbon now available in very large quantities from the pyrolysis of crude petroleum, and a full-scale plant for this purpose has been in operation in the United States since 1948. It is therefore unlikely that acute glycerine shortages will recur in the future. In normal circumstances it seems probable that the bulk of industrial glycerine will continue to be provided by the saponification of natural fats and fatty oils, while synthetic glycerine from propylene and, possibly, also glycerine from modified sucrose fermentation, will restrain any of the violent price fluctuations which formerly affected this market. T. M. Godfrey, who contributes the section of Miner and Dalton's monograph on methods of production, considers that, owing to refining difficulties, glycerine from sugar fermentation will not compete economically with that from the hydrocarbon synthesis; this is a matter of opinion, since there may be further scope for development in the recovery of glycerine from the fermentation liquors.

The widespread importance of industrial glycerine and the manner in which it has been possible to introduce supplies by methods alternative to its production from natural fats form a chapter in applied organic chemistry which will be of interest to the general reader. The purpose of the volume which has inspired the foregoing reflexions is, of course, more especially for those concerned in any way with glycerol, its production and its products. For these it will be found well presented and documented, and admirable in every way except its somewhat formidable price. The sections on the sources of glycerol technically available in natural fats and on its methods of production are specially valuable. The processes for hydrolysis of fats, concentration of glycerine to the 'crude glycerines' containing 80–90 per cent of glycerol, and distillation of the latter to yield 'distilled' or 'dynamite' glycerines are fully described with adequate diagrams and illustrations, and later sections (by J. B. Seger) deal with various agreed trade specifications for glycerine and with the many methods of analytical control required to ensure conformity with these. The last section of the monograph, devoted to the uses of glycerine, will prove of as much interest to the general reader as to the glycerine specialist.

The sections on the physical and chemical properties of glycerol and its derivatives are extremely detailed and contain a very large amount of valuable information. They occupy, however, 160 pages—more than one-third of the book; it might have been desirable, for the sake of producing a somewhat less expensive volume, to have considered whether these sections could not profitably have been materially condensed. This is the only criticism which it is desired to make about a monograph which is not only excellent but which was also needed. T. P. HILDITCH

ASPECTS OF MODERN METALLURGY

(1) The Metallurgy of the Rarer Metals
Institution of Metallurgists. (Lectures delivered at the Institution's Refresher Course 1952.) Pp. 156. (London: Institution of Metallurgists, 1953.) 15*s*. 6*d*.

(2) The Physical Chemistry of Copper Smelting
By R. W. Ruddle. Pp. 156. (London: Institution of Mining and Metallurgy, 1953.) 20*s*. (10*s*. to I.M.M. members).

(3) Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys
A Symposium on Metallurgical Aspects of the subject held in London on the occasion of the Annual General Meeting of the Institute, 26 March 1952. (Institute of Metals: Monograph and Report Series No. 14.) Pp. 104. (London: Institute of Metals, 1953.) 15*s*.

(4) The Physical Chemistry of Melts
A Symposium on the Nature of Molten Slags and Salts held by the Nuffield Research Group in Extraction Metallurgy, London, 20th February 1952. Pp. 106. (London: Institution of Mining and Metallurgy, 1953.) 15*s*. (7*s*. 6*d*. to I.M.M. members.)

THESE four monographs, although containing little which is really new, are all able and valuable compilations.

(1) The first, dealing with the metallurgy of the rarer metals, is a collection of lectures delivered at the refresher course arranged by the Institution of Metallurgists in 1952. The metals considered by authors specially fitted to discuss them are uranium, beryllium, molybdenum, tungsten, titanium and zirconium, tantalum and niobium, metals of the platinum group and 'pure' chromium and manganese. Something is said in most cases about the preparation of the material, and its properties, uses and metallography are in each case considered.

(2) The consideration of the present state of the physical chemistry of copper smelting is most competently dealt with by Mr. R. W. Ruddle, of the British Non-Ferrous Metals Research Association, and represents apparently the preliminary study necessitated before further work on the extraction of copper is undertaken in that Association's laboratories. In the seven chapters, each of the important sections of the smelting process is considered in detail, and even those who are not directly concerned with the metallurgical aspects of the processes may find the treatment of the recovery of sulphur from the smoke of considerable interest. The book is an admirable summary of existing knowledge, well presented and discussed.

(3) In March 1952 the Institute of Metals held a symposium on the metallographic aspects of the equipment required for the thermal treatment of non-ferrous metals and alloys. The papers submitted are now published and should be of interest to all those who are concerned with the heat-treatment of metals, not only non-ferrous. Electric furnaces and

gas equipment are first considered, there is then a paper on batch and continuous annealing of copper and copper alloys, one on the bright annealing of nickel and its alloys, and finally three papers on the batch treatment, flash annealing and continuous heat-treatment of the alloys of aluminium. Twenty-nine plates give a very clear idea of the type of equipment which has been designed and used. The papers, however, are no mere description of plant and apparatus, this being linked to the underlying mechanical and metallographic changes which the treatments are desired to effect. The importance of the atmosphere in which the heating is carried out is emphasized in more than one of the communications, and in that on the bright annealing of nickel and its alloys is discussed in some detail. The utility of the papers is further enhanced by the discussion which resulted, and the whole forms a contribution to the subject of real importance.

(4) In some ways the fourth of these monographs is the most outstanding. In February 1952 a symposium was held on the nature of molten slags and salts by the Nuffield Research Group in Extraction Metallurgy, which is working at the Royal School of Mines, London, on the reactions of systems connected with the winning and refining of metals. Two papers deal with the constitution of liquid oxides and silicates; anomalies in the surface tension of silicates are then considered; and three other papers deal with the correlation between activity and composition in mixtures of fused salts, heats of mixing in the liquid ferrous oxide–silica system and the thermodynamic aspects of molten slags. Each of these presents a clear picture of the present state of knowledge, and it will perhaps surprise many readers to find how wide this already is. To those who are in any way concerned with the physical chemistry of molten salgs and salts, this little book may be most strongly recommended.

F. C. Thompson

INORGANIC CHEMISTRY FOR THE GENERAL STUDENT

General and Inorganic Chemistry

By Dr. P. J. Durrant. Second edition. Pp. x+671. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1952.) 21*s*.

Reference Book of Inorganic Chemistry

By Prof. Wendell M. Latimer and Prof. Joel H. Hildebrand. Third edition. Pp. xiii+625. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1952.) 37*s*. 6*d*. net.

At a time when the supply of scientific workers and technologists is of national importance in Britain, it is a matter of some concern to consider their early training, so often provided in the sixth forms of schools. The teacher at this stage has the heavy responsibility of laying firmly and wisely the foundations of the sciences, while at the same time encouraging interest and enthusiasm in a particular science, frequently chemistry. To achieve this in a rapidly advancing subject such as chemistry, the methods of presentation must be constantly under review. The teacher has available to aid him in this several excellent text-books, constantly under revision, which are known affectionately by the names of their authors. "Durrant" is one of these, now appearing in a second edition.

The new edition has several modifications and additions, including a completely revised chapter on valency, atomic structure and the periodic table, which now introduces the numerical concept of electro-negativity as well as the qualitative treatment afforded by Fajan's rules. The importance of ions in the understanding of a great deal of 'elementary' chemistry is emphasized by revision of the chapters dealing with electrolytes, electrode potentials and electrolysis. The treatment given to the electrochemical series and to electrode potentials will be of particular value to teachers. New chapters have been added to cover colloids and nuclear chemistry (including nuclear and thermo-nuclear energy). A treatment of colloids forms an essential part of any elementary course intended to introduce the student to the chemistry of the world about him, and its inclusion is thus to be especially welcomed. In some measure the same may be said of 'nuclear chemistry' in this atomic age.

A modified form of the periodic table due to Prof. T. S. Wheeler is used in which the *A* and *B* sub-groups of the short table are re-styled *N* and *T* (normal and transition) sub-groups. Some will find its use advantageous; but it seems to me that the subject is at such a stage of development that the few advantages of the short form should be shelved in favour of the exclusive use of the more open and obvious long form.

The book is well prepared, and there are only a few trifling mistakes. On a point of nomenclature it is unfortunate that the author should have deviated from what has become established practice in referring to the 'actinides' as 'uranides'. A particularly attractive feature of the book is the large number of questions (401) covering a very wide range of sources. This text-book will continue to play an important part in the teaching of 'elementary' chemistry, and the revised second edition is to be highly recommended both for school and university work.

The third edition of the "Reference Book of Inorganic Chemistry", by Profs. W. M. Latimer and J. H. Hildebrand, is not intended primarily as a text-book, but can be adapted by the teachers to suit their own particular requirements and thereby provide the elementary student with a book containing a wealth of facts arranged and rationalized mainly in terms of the atomic structures and fundamental properties of the elements. As a reference book its value may appear doubtful because of its size, which is very small compared with the better-known reference books of inorganic chemistry. However, there has been a most skilful selection of facts, and there is a surprising amount of material contained within the 511 pages of text and the 86 pages of glossary and appendix. Much of the information in the text is summarized in tables setting out data for particular groups of elements or compounds. The appendix includes a large collection of useful data (notably a table of the m.p., b.p., density, etc., for around 1,300 inorganic substances). This third edition is considerably revised from the second edition (1940), and includes a new chapter on nuclear reactions and the actinide elements. It is unlikely to find any great use in Britain as a text-book, since more suitable works are available; but as a handy source of simple facts or data of inorganic chemistry it will be a decidedly useful volume to have on the bookshelf.

D. S. Payne

Trusts and Foundations

A Select Guide to Organizations and Grant-making Bodies Operating in Great Britain and the Commonwealth. Compiled by Guy W. Keeling. Edited by Thomas Landau. Pp. xi+194. (Cambridge: Bowes and Bowes Publishers, Ltd., 1953.) 42*s*. net.

IN the foreword to this book, Lord Nathan, formerly chairman of the Committee on the Law and Practice relating to Charitable Trusts, points out that, though the Charitable Trusts Act has been in operation for a hundred years, this year being in fact its centenary, yet no one, not even the Charity Commissioners, can say with precision how many charitable trusts exist in England and Wales. The figure given to Lord Nathan's Committee is eleven thousand; but it is generally agreed that the actual number is greater. The present work gives a selection of a thousand bodies within Great Britain and the British Commonwealth that afford grant-aid, with information supplied by them regarding their resources and activities. Each body is given a separate paragraph, and they are listed in alphabetical order, the whole taking up more than three-quarters of the book. The rest of the space consists of a classified index arranged according to the Dewey Decimal Classification, an alphabetical subject index, an appendix of grants made by government departments to voluntary agencies, and a bibliography, this last-named being divided into a list of local directories arranged by county and town, and a list of publications arranged by subject. The value of this guide as a whole lies principally in the amount of time that it will save, both for applicants and for the body that is approached. In spite of the increased amount of money that is nowadays forthcoming from the State, there is still a need for these private trusts, for, as many a research worker will testify, they perform a valuable service in many fields of scholarship and welfare. So long as they continue, it is essential that those seeking grants should know which is the appropriate body to turn to, and this book is a modest start in regard to providing such information.

Common Ocean Fishes of the Californian Coast

Fish Bulletin No. 91 of the Marine Fisheries Branch, Department of Fish and Game, State of California. By Phil M. Roedel. Pp. 183. (San Francisco: Dept. of Fish and Game, 1953.) n.p.

THIS bulletin is designed as a guide to those marine fishes of California that are likely to be caught by commercial and sporting fishermen. Deep-sea fishes and the small forms from inshore waters that rarely, if ever, enter the fishermen's catches are not included. This guiding precept of likelihood of capture by fishermen has resulted in the inclusion of some species that are actually quite rare in California and the exclusion of some ordinarily common ones. The bulletin is meant for everyone interested in fishes regardless of his technical background, and scientific terminology has been kept to a minimum. Such terms as do appear are defined in a short glossary.

A brief description of each species is accompanied (with only a few exceptions) by a photographic illustration of an adult fish. Most of the illustrations are of a reasonably high standard; but a few—of admittedly difficult subjects—are disappointingly poor. Notes on fishing seasons and fishing gear are also provided. In addition to its scientific name, each fish is given what is described as an "official" common name. These "official" common names have been assigned by the Department of Fish and Game of the State of California in order to obtain reasonable consistency in terminology—an essential in the collection of accurate statistical and other information.

An identification key is included for the more common species. Such an incomplete key is often more of a hindrance than a help to the unwary novice who tries to identify a specimen that is not in the key. How is he to know whether his failure to name his fish is due to its omission from the key or to his having 'taken a wrong turning' somewhere? To be of real use a key must contain all the species likely to turn up. This, however, is a small point—and keys are notoriously difficult to compile, anyway.

A University Text-Book of Physics

Vol. 3: Heat. Being the eleventh edition and a largely rewritten version of Poynting and Thomson's "Text-Book of Physics", Vol. 3. Pp. x+439. (London: Charles Griffin and Co., Ltd., 1952.) 36*s*. net.

THE publication of this book raises an interesting question. Can a text-book which was brilliantly successful thirty years ago be successfully revised for the present generation of students? The reviewer regretfully feels that the answer must be 'no'. Mr. J. H. Awbery has made a valiant attempt to bring the material up to date; but there is no doubt that, during the past thirty years, the scope of physics teaching in the universities has vastly changed (for better or worse), and much of what appears in this book is now of pre-university standard. In the final chapters, on thermodynamics, where the revision has been greatest, modern standards are adhered to; but then there are other books (including Mr. Awbery's own) which deal successfully with this part of the subject.

In the reviewer's opinion, therefore, it is wiser to leave the classics as they were written for their own times, and to allow the present generation of authors to produce their own text-books in their own way.

H. L.

Weather Inference for Beginners

Made clear in a Series of Actual Examples. By D. J. Holland. Pp. xiv+196. (Cambridge: At the University Press, 1953.) 30*s*. net.

IN this book the author adopts the novel idea of taking the weather-changes over a sequence of days (in the autumn and winter of 1936) as he observed them in London with the simple apparatus available to a boy, and using them as the text for a series of simple explanations of the physical processes in the atmosphere which caused them. Both physics and meteorology are fairly advanced but should be quite intelligible to most readers, except perhaps where vectors are introduced, and this part of the book should be very useful to science teachers in schools where weather records are kept. Later, the observations are related to simplified synoptic charts of western Europe for the same period, and the reader is introduced to anticyclones, depressions and fronts. The remarks on frontal analysis should be of value to young entrants to the meteorological services learning the elements of weather forecasting, as also should be the concluding chapter on upper-air analysis, use of analogues and other aspects of practical forecasting. The chief difficulty, for the readers for whom the book is intended, is likely to be the high price, due no doubt to the lavish production.

THE CONTINENTAL SHELF

ONE morning of the British Association meeting at Liverpool was devoted to a joint discussion by Sections C (Geology), D (Zoology) and E (Geography) on problems of the continental shelf. First, Dr. L. H. N. Cooper, of the Marine Biological Laboratory, Plymouth, developed a hypothesis to explain the fluctuations in biological productivity of the English Channel in terms of climatic conditions in the Arctic. During the 1920's the Channel contained about 0·7 μgm.-atom/litre phosphate as measured at the winter maximum, and there occurred an abundant macroplankton characterized by several biological indicators, including *Sagitta elegans*. About 1930 the winter maximum of phosphate fell and settled down at about 0·45 μgm.-atom/litre. This was accompanied by a marked decrease in abundance of macroplankton and a change in the indicator species, *S. setosa* replacing *S. elegans*. Herrings also became less abundant, and after 1934 the Plymouth commercial herring fishery was completely extinguished. Evidence for a complementary earlier enrichment is incomplete; but there is some evidence for it shortly before the nutrient studies started in 1923. An explanation is likely to be in terms of an event that occurs only a few times in a century.

During the years 1947–50 the search for an explanation was extended to the Celtic Sea, south and west of the Scillies. Waters were found of *elegans* type and richer in phosphate than those near Plymouth; but none was as rich as that in the Channel during the 1920's. Within this area there is not a single clue which would suggest to-day a physical regime fundamentally different from that of thirty years ago. Since, whatever the ultimate cause may be, it is not local, the search has to be extended to the Atlantic Ocean.

Upwelling due to off-shore or off-slope winds is one possibility. However, during six weeks covering the notorious February of 1947, easterly winds were strong enough and lasted long enough to bring about upwelling of deeper water, but no enrichment ensued. Work later on R.R.S. *Discovery II* showed that to-day in the neighbouring Atlantic adequate nutrient resources are not within reach of any physical forces which could bring them to the surface. To make this possible, the nutrient table containing 0·8 μgm.-atom/litre would need to be raised by about 400 m. The conclusion seems inescapable that thirty years ago this nutrient table must indeed have lain 400 m. higher in the water than it does to-day and that it had been raised by upward displacement by an equal volume of water intruded at a greater depth, perhaps at the very bottom of the Atlantic. Abyssal water is always cold, having sunk from the surface in winter in high latitudes. It was concluded that much polar water must have sunk in the years before 1921 and that relatively little is sinking now.

Two events are necessary for the production of deep water in high latitudes: the presence of water of sufficiently high salinity; and air temperatures low enough to cool this saline water sufficiently for it to become the heaviest water in the North Atlantic. A principal northern area where this may occur is around southern Greenland. A series of cold winters there during the first twenty years of this century culminated in three very harsh winters in 1918, 1920 and 1921, during which time much deep Atlantic water must have been formed, leading to upward displacement of the overlying water. Nothing comparable has been experienced since, so that upward displacement and resulting nutrient enrichment of surface waters should have become much reduced.

It is suspected that this conclusion has emerged first from work on the English Channel because this has mostly a rock or sand bottom. Due to its strong tidal currents, there is little local deposition of organic mud or ooze. In regions of weaker tides, during years of rich production a capital reserve of organic mud is thought to be laid down and then by slow decomposition to yield dividends of nutrients and growth-promoting substances for many years afterwards. Thus, in such places, the failure to recruit fresh supplies of nutrients derived from oceanic upward displacement may be masked.

In the discussion, Dr. R. E. Craig, of the Scottish Home Department Marine Laboratory, Aberdeen, strongly supported the policy of looking at major climatic changes as first causes of observed hydrographical and plankton changes, but felt that the hypothesis merely presents a mechanism for increasing the thermal circulation and cannot necessarily be expected to raise the level of any of the horizontal boundaries in the sea. He also felt that 1921 was in every way an exceptional year able to produce the observed changes by the means which he outlined.

The Bear Island Shelf was the subject of a paper by Mr. Michael Graham and Mr. A. J. Lee, of the Fisheries Laboratory, Lowestoft. It lies between Norway and Spitsbergen, receiving from the north-eastwards a cold current against which two branches of warm, more saline Atlantic water impinge: the West Spitsbergen and the North Cape currents. As it is the site of the greatest single British fishery, conditions over it have been extensively studied by the fisheries research vessel *Ernest Holt*. The success of the fishery is found much to depend on where and to what extent Atlantic water of temperature 2–4° C. touches the sea bed. In March 1949 west of Bear Island such water extended from a depth on the shelf of about 150 m. to beyond the trawlable limit of 500 m. There was no ice about. On the same date in 1950 there was ice extending 30 miles west of the island, and no water warmer than 2° C. was found above 220 m.—that is, 70 m. deeper and about nine miles nearer the edge of the shelf. The breadth of the trawlable zone had become less than ten miles.

In 1949 much saline Atlantic water was present, having been blown there by preceding south-easterly winds. The presence of such saline water favours the formation of homogeneous water and hampers the development of surface ice. The distribution of density showed that the shelf waters west of Bear Island had become heavy enough to cascade over the edge and down the continental slope. In Mr. Lee's opinion, cascading down the slope of the shelf is an essential part of the mechanism thought to govern this spring fishery. The conditions of the fishery during the rest of the year were also described.

The title of the last paper, "Territorial Problems associated with the Continental Shelf", whetted

curiosity since few of the audience realized that there were any. Dr. A. E. Moodie, a geographer of Birkbeck College, London, presented to zoologists and geologists an account of the evolution of international law relating to the sovereignty of coastal States over the continental shelf. Though the implications were clear enough, the story seemed as unreal as that of a comic opera and could have no place in a discussion on natural science. [See also p. 1063 of this issue of *Nature*.]

Since 1939, and especially since 1945, there has been a spate of claims to exercise sovereignty over the shelf, especially by American Republics. The United Kingdom has been party with Venezuela to a division of the Gulf of Paria. Motives have been twofold: the search for oil and the attainment of security. Many unilateral claims have been extravagant, and the legal position was becoming chaotic. In 1948, therefore, the General Assembly of the United Nations recommended to the International Law Commission that it should give priority to discussions on the regime of the high seas. After five years of argument and counter-argument, the Commission has agreed to recognize in principle qualified sovereign rights of a coastal State over the adjacent part of the shelf. It does not follow that the General Assembly will accept them.

The latest information available to Dr. Moodie was United Nations Press Release *L*/47, dated July 17, 1953, while the jurists were still sitting. The draft articles in full with an extended commentary were published on August 17 as United Nations General Assembly *A/CN.4/76*, pp. 35–56. This document shows that the Commission recommends that all contiguous waters shall be divided into two zones: the territorial sea, broadly equivalent to the present concept of territorial waters extending from the coast for three or some other number of miles to seaward; and the continental shelf, extending from the limit of the territorial sea to a depth of 200 m. The major difference in legal status will be that within the territorial sea the coastal State exercises, as previously, complete sovereignty over sea-floor, subsoil and superjacent waters, whereas over the continental shelf the superjacent waters and air-space will not be subject to the sovereignty of the coastal State. Over the whole of the continental shelf the coastal State will exercise sovereignty over the exploration and exploitation of the sea-bed and subsoil, just as it does over its land territory. The extension of the seaward boundaries of a coastal State to the 200-m. contour means a very great extension of the State's authority and could in some circumstances become a grave hindrance not only to trade and fishing but also to scientific research. Juridical problems, affecting the freedom of marine research, may arise when two or more States lie adjacent to the same continental shelf.

XIX INTERNATIONAL PHYSIOLOGICAL CONGRESS, MONTREAL

THE XIX International Physiological Congress was opened in the Sir Arthur Currie gymnasium of McGill University, Montreal, on Monday, August 31, 1953, at 5 p.m., by the president, Prof. C. H. Best, of the University of Toronto. The platform party made an imposing entry to the large gymnasium filled with more than two thousand members of the Congress, who stood in respect as their senior colleagues, together with the dignitaries of Montreal and of Quebec Province, passed along the centre aisle. This impressive stage-management was characteristic of the superb efficiency with which the local organizing committee, ably led—and perhaps driven—by Prof. F. C. MacIntosh, of McGill University, had organized the whole of this vast Congress.

Following the official opening of the Congress, the remainder of this plenary session consisted of speeches of welcome from Dr. J. B. Collip, president of the Canadian Physiological Society, which was the host organization to the Congress; from Dr. F. C. James, principal of McGill University, on behalf both of McGill University and of the University of Montreal; from Mayor Camillien Houde, on behalf of the city of Montreal; and from Dr. G. D. W. Cameron, deputy minister of health, on behalf of the Government of Quebec. The president of the Congress conveyed the thanks of all members to the many host organizations, in a large variety of languages, including Iroquois; in fact, the linguistic attainments of the platform party were astonishing, from Dr. Collip's speech in French, onwards; but the thunder of the whole session was stolen by Mayor Houde, whose memorable address made even vital statistics vital. Shortly before the close of the meeting, Dr. E. D. Adrian, of the University of Cambridge, outlined the plan of the Permanent Committee, of which he is president, for the establishment of an International Union of Physiological Sciences, and promised members that the Permanent Committee at least intended to work during the Congress—and hoped to present the final recommendations at the closing plenary session. The entire concourse then made its way very slowly up a steep hill to Forbes Field, where, in the open air, all were entertained at the hands of the Provincial Government of Quebec. This reception was memorable, not only for being held in such pleasant surroundings, not only for the unrivalled opportunities for meeting, for the first time, many of one's fellow members, not only for the generous spirit of the Government of Quebec, but also for a buffet which broke all records in running out of soft drinks and soda-water only. In this way then did August fade away, and on the first of September members were faced with a staggering programme of scientific sessions, and the technical work of the Congress began.

It is said in North America that only the English can talk uninterruptedly for longer than thirty seconds about the weather; but all racial records were broken in Montreal, where, despite the unparalleled opportunities for 'shop', the climate must surely have taken pride of place as a subject for discussion. The Congress basked or baked in temperatures that seldom—or was it ever?—fell out of the 90's, and members were little comforted by the repeated assurances of the 'locals' that this was most unusual for the time of the year. Recollection of sessions in hot and crowded lecture halls will remain long after memory of the scientific proceedings has faded; but more comfortable recol-

lections of the ample standing, seating and lying accommodation will also linger.

There were some 2,750 registrations in all, more than two thousand being full members of the Congress. There were eight symposia, eighteen films, fifty-eight demonstrations and 792 communications. This programme was completed in a total of seven half-day sessions, and there were never fewer than fourteen nor more than seventeen concurrent activities. This report must therefore be selective and must inevitably show bias in referring mainly to work in one major field of interest; it is proposed to mention only a few points of interest from the 792 communications and to describe briefly the subject-matter of the symposia.

The organization of an international meeting of this magnitude throws an indescribable burden of work on the scientific personnel of the host country and, even more, of the host city. One is inevitably left reflecting whether it is worth the labour, or whether some alternative plan for the Congress would not ease the load. The idea of more frequent, small-scale international symposia is attractive and is becoming more and more a feature of scientific discussion nowadays; but they can only serve as an adjuvant to the full Congress. Let us therefore accept the restrictions and the inevitable frustrations of the large-scale meeting, and agree that only at such a meeting can one meet and talk with those in wholly different fields of work; more can be learned in private conversations than in formal lecture halls.

First, in the neurophysiological field, R. Stämpfli (Berne) has introduced a 'simple' method for measuring membrane potentials and, as a result, we may find that, in the future, even the old-school pharmacologists will indulge in talk of "resting potentials".

V. B. Brooks (Montreal) provided a beautifully logical exposition of the action of *Botulinus* toxin in blocking conduction in the fine non-myelinated terminal filaments of motor nerves. This has long been assumed but never before so adequately proved.

A. von Muralt (Berne) has further enlarged the neurophysiological vocabulary with 'stroboscopic photochemistry' and, with elegant technique, has shown that light at various optimal wave-lengths can greatly influence the threshold of a single nerve fibre. The changes depend on the time relationship between the light flash and the electrically excited action-potential; and on whether the flash is directed on a node of Ranvier or on an internode. Light of wave-length 280 mμ can inactivate enzymes which may play a part in the chemical reactions providing the free energy for the maintenance of excitability.

It was a pity that A. V. Kibjakow (Kazanj, U.S.S.R.) was not present to read his paper (read by title only), for the abstract is most stimulating. In particular, it is interesting to note that he finds that chronic pancreatectomy reduces the output of acetylcholine from cholinergic nerve-endings. He has resisted the obvious temptation to speculate as to the reason for this observation, except to attribute it to a disturbance of phospholipid metabolism. He proceeds, however, to discuss in considerable detail the function of the animal thus partially deprived of one of the mediators of nervous transmission, and further open discussion of this question might have been most enlightening.

H. Konzett and E. Rothlin (Basle) settled one outstanding query in connexion with the effects of denervating an organ when they showed that neither the increased sensitivity of ganglion cells to acetylcholine nor the depletion of cholinesterase in the ganglion—both of which are found after denervation—is obtained after long-term block of ganglion transmission with a ganglion-blocking drug. Thus, the 'trophic' effect exerted by the intact pre-ganglionic fibres cannot be dependent upon constant reaction of the cells to the normal transmitter.

E. M. Vaughan Williams and S. W. Kuffler (Oxford and Baltimore) have most ingeniously devised a means of recording both 'fast' or 'twitch' and 'slow' striated muscle fibres in the frog rectus muscle, and have shown that the muscle responds to acetylcholine by a contracture due to activation of the 'slow' muscle fibres only, the 'twitch' fibres relaxing rapidly in the acetylcholine solutions. It appears that no muscle fibres have a double innervation, the 'slow' fibres being innervated by small-diameter nerves only. This work has gone far towards resolving the nature of the system used, in ignorance, for so long as a routine pharmacological test for acetylcholine activity.

R. H. Beutner (Little Rock, U.S.A.) and T. C. Barnes (Philadelphia) discussed artificial cell membranes; both have long used a lipid-saline interface as a physical model of a cell membrane, and the 'electrogenic' effects of acetylcholine on such a system are impressive. Recent advances in our knowledge of the nature of the action potential has, however, convinced most of us that these models can only be regarded as a vast over-simplification of a most complex situation.

F. C. MacIntosh and P. E. Oborin (Montreal) presented what must be the first convincing evidence that acetylcholine is involved in cerebral cortical activity. The acetylcholine released is collected in a small 'Lucite' cup containing eserinized saline placed on the surface of the cortex. Fluid transudes from the cortex into the cup at a rate of about 0·02 ml./cm.²/min., and the concentration of acetylcholine in this fluid during light anæsthesia may be as high as 3×10^{-7} gm./ml. The amount of acetylcholine released is proportional to the electrical activity of the cortex and may be modified by the depth of anæsthesia. The acetylcholine is not derived from parasympathetic vasodilator fibres, and the fluctuation in the amount of acetylcholine released is not accounted for by changes in cerebral blood flow.

Ruth S. Geiger and A. Behar (Jerusalem) described a technique for the growth of neurones in tissue culture. They used grey matter from adult rabbit brain and observed mitosis of neurones in the cultures. Cortisone was more successful than embryo brain extract as an adjuvant to the basic Tyrode's solution and serum mixture; it increased the survival time of individual neurones, prevented the growth of most cells other than neurones, and increased the frequency of mitosis in neurones ten to twenty times.

A. O. Zupancic (Ljubljana, Yugoslavia), who was unfortunately not present, made the suggestion in his abstract that the receptors on cell membranes, to which specific transmitters attach themselves, are one and the same molecules as the enzymes responsible for their destruction. This interesting speculation has many attractions, but seemed somewhat at variance with the findings obtained by

specific staining for enzymes, which indicate that although the cholinesterase at the end-plates of striated muscle appears to be located at the post-synaptic membrane, the cholinesterase at the ganglion synapses seems to be mainly in the pre-synaptic terminals.

Turning to fields other than neurophysiological, it was noted, in passing, that C. P. Lyman and D. W. Fawcett (Boston) had shown that exposure to cold of a hibernating mammal (the golden hamster) causes a desaturation of the white fat, whatever the degree of saturation of the dietary fat. This explains how the hibernating animal can maintain its fat stocks in the fluid state, in spite of the fact that fat from animals maintained at 22° C. is semi-solid at 5° C.

H. E. Essex, H. L. Smith and E. J. Baldes (Rochester) did great service for the average medical student—shades of the ward-round !—in producing a first-rate film (with sound recordings), illustrating beyond reasonable doubt that the first heart sound can be attributed to closure of the mitral and tricuspid valves, and the second to the closure of the aortic valves.

Both D. R. Drury and A. N. Wick (Los Angeles) and R. Levine and M. S. Goldstein (Chicago) read papers supporting the view that the action of insulin in facilitating the metabolism of glucose is due, not so much to a direct effect of insulin upon the responsible enzyme systems but to its effect in promoting the transfer of sugar across the cell membranes, and hence, indirectly, to a more rapid intracellular metabolism.

A whole morning was devoted to papers on glucagon, the hyperglycæmic factor of the pancreas. There has long been scepticism about this 'hormone', but it now appears that it is a real entity. A. Staub, L. Sinn and O. K. Behrens (Indianapolis) described its isolation in crystalline form, and C. de Duve and C. A. Vuylsteke (Louvain) also had achieved a substantial degree of purification. De Duve and Vuylsteke have also improved the assay method using isolated rabbit-liver slices, originally proposed by Sutherland and de Duve. A group meeting on glucagon was also held during the Congress, and it was suggested that the question of standardizing glucagon should be referred to the World Health Organization.

Two group meetings on secretin, organized by M. H. F. Friedman (Philadelphia), were held, and a series of recommendations about the establishment of an international standard for secretin was prepared for submission to the World Health Organization.

D. J. Smith (Burlington, U.S.A.) showed that thyroxine can exert an immediate effect on isolated arteries, increasing their sensitivity to adrenaline by some 250 per cent. The sensitivity of vasa vasorum was even more greatly enhanced by thyroxine. Smith suggested that these effects were due to inhibition of amine oxidase by thyroxine.

R. Carrasco-Formiguera and N. Pi-Sunyer (Caracas, Venezuela) have provided further evidence that the shift in the Arneth count, observed in clinical hyperthyroidism, is attributable only to a hypersecretion of thyrotrophic hormone and, like exophthalmos, is not produced directly by thyroxine.

H. C. Meng and Charlotte Hollett (Nashville, U.S.A.) have succeeded in partially separating the anti-coagulant and the lipæmia-clearing activities of heparin by various chemical procedures which reduce the anti-coagulant activity only. The relationship of these findings to the chemical structure of heparin is still unexplained.

Many members of the Congress were interested (and amused) to note that J. Ek and B. Josephson (Stockholm) have found that beer is just as good a diuretic as theophylline—and that this is quite independent of its volume and action in producing a simple water diuresis. The National Health Service in Britain may find even more 'proprietaries' being prescribed as a result.

The symposium on the morning of September 1 on the metabolic influence of insulin was held under the chairmanship of Dr. B. A. Houssay. The principal speakers were F. D. W. Lukens (Philadelphia) on the influence of insulin on protein metabolism; De Witt Stetten (New York) on the inter-relationship of carbohydrate and fat metabolism; F. G. Young (Cambridge) on the inter-relationship of pituitary and pancreas; and W. C. Stadie (Philadelphia) on the action of insulin *in vitro*. These papers were largely reviews of present-day knowledge of these facets of insulin metabolism; but Lukens had fresh evidence to show that carbohydrate in the diet led to nitrogen retention in normal but not in hypophysectomized cats, and Young, that in adrenalectomized animals purified growth hormone exerts a diabetogenic action. Stadie's stimulating paper described experiments *in vitro* on the binding of insulin by various tissues. Of all tissues examined, only brain failed to bind insulin, and by using insulin labelled with radio-active isotopes of sulphur and iodine, it had been possible to determine insulin in amounts of the order of 0·01 μgm. Measurements have been made in this way of the effect of insulin upon the synthesis of glycogen in strictly quantitative terms of tissue, substrate and hormone.

In the afternoon, a symposium was held under the chairmanship of Dr. B. Folkow on the hæmodynamics of small vessels. The principal speakers were A. C. Burton (London, Ontario), B. W. Zweifach and D. B. Metz (New York), J. R. Pappenheimer (Boston) and H. Barcroft (London, England). Burton spoke of the structure and function of the elements in the wall of blood vessels; Zweifach and Metz on the functional behaviour of the terminal vascular bed; Pappenheimer on molecular exchange processes in the capillary circulation; and Barcroft on the control of muscle blood flow. Barcroft's contribution, given with typical modesty, was a masterly exposition of what is, and is not, known in this field. The dilatation of the vessels supplying active muscle fibre appears to be entirely accounted for by some change in muscle initiated by the contractile process.

The first of the symposia on September 2 was held under the presidency of Dr. C. F. Schmidt, on reflexes from the cardiac and pulmonary areas. C. Heymans (Ghent) led off with a paper on sino-aortic receptors, in which he reviewed the work on the carotid body, including his own classical and elegant experiments which began in 1924 and are still continuing. O. Krayer (Boston) reviewed the history of the Bezold–Jarisch effect, and was followed by G. S. Dawes (Oxford) on reflexes from the heart and lungs. Dawes attempted a badly needed survey of the many reflexes which have been reported in the literature and appealed for clarity in describing them, and for the necessity

for the adoption of rigid criteria for their classification. He ended with the speculation as to whether many of these reflexes, excited as they are only by drugs, have any useful purpose in normal life. Y. Zottermann (Stockholm) read a paper on electrophysiological investigations of afferent fibres from the carotid sinus region, and made the interesting suggestion that acetylcholine acts as a transmitter of impulses in the carotid body, the glomus cells and the nervous end-plates corresponding to functional synapses. This is a point of lively controversy which has excited discussion for many months. Finally, D. Whitteridge (Edinburgh) discussed the electrophysiology of afferent cardiac and pulmonary fibres, and described new work in his laboratory by Paintal, who has developed an interesting method for the isolation of single small fibres based on conduction-rates. This was, in all, an excellent symposium of papers of a uniformly high standard of excellence.

On the afternoon of September 2, under the presidency of Dr. F. Bremer, a symposium was held on postural mechanisms. This was opened by S. W. Kuffler (Baltimore) on segmental mechanisms, in which he began by assessing our knowledge of posture as rudimentary, and ended on a Sherringtonian note with the conclusion that postural tone is part and parcel of ordinary motility. He was followed by B. R. Kaada (Oslo) on suprasegmental mechanisms. This paper also showed a well-marked integrative action and introduced the role of the labyrinth, the cerebellum and the reticulum. H. W. Magoun (Los Angeles) went on to describe in more detail reticular and striate mechanisms of postural control, and G. Moruzzi (Pisa) rounded off another successful symposium with a paper on cerebellar and cerebral mechanisms. His review was highly technical and somewhat difficult to follow, as indicated by the fact that he cited no less than ninety-five references.

On the morning of September 3, the symposium was on the more general subject of the physiological theories of learning, the chairman being Dr. K. S. Lashley. J. Z. Young (London, England) led off on the learning system of octopus. This work, though lacking somewhat in pristine freshness, is none the less of great importance. R. W. Sperry (Bethesda) continued on regeneration studies and learning, and presented some most interesting data, together with a somewhat rarefied discussion of their physiological, psychological and even philosophical bases. He was followed by K. M. Bykov (Leningrad) on the physiology and pathology of the cerebral cortex. Here again, the rarefied atmosphere of dialectical materialism, coupled with the more mundane difficulties of language, made real insight into his thesis somewhat tricky. The symposium ended with a contribution from A. K. MacIntyre (Dunedin) on synaptic function and learning, which came as a welcome return to the bedrock of electrophysiology.

On the morning of September 4, the symposium was on the mechanism of formation of the thyroid hormone, the chairman being Dr. J. Roche. The principal speakers were E. B. Astwood (Boston) on iodine-collecting mechanisms; R. P. J. Michel (Paris) on the localization and the mechanism of iodination concomitant with the formation of thyroglobulin; E. D. De Robertis (Montevideo) on the physiological hydrolysis of thyroglobulin in the thyroid gland; J. Gross and Rosalind Pitt-Rivers (New York and London, England) on the passage of tri-iodothyrin and thyroxin into the circulation. Finally, during the afternoon, a symposium was held on the physiology of cold, in which the principal speakers were E. F. DuBois (New York) on the physiology of homœothermic animals exposed to cold; L. P. Dugal (Quebec) on endocrine glands and cold; C. Kayser (Strasbourg) on hibernation in mammals; O. G. Edholm (London, England) on the effect of cold on the circulation of man; and Norma C. C. Kent and N. H. Mackworth (Cambridge) on the effects of cold on human efficiency.

To add to the already bewildering choice of activities that confronted members of the Congress, there were a large number of open, semi-private or private meetings of specialist groups, organized by various private individuals, and held, in the main, concurrently with the official sessions. The largest of these and the only one which it is possible to mention ran as an open meeting for the whole of one day. It was organized by Prof. C. von Euler (Stockholm) on the subject "Biologically Active Polypeptides". It was at this meeting that Van Dyke (New York) announced what was perhaps the most notable scientific advance reported at the Congress, namely, that Du Vigneaud (New York) had succeeded in synthesizing the oxytocic hormone of the posterior pituitary. This is in every way a major advancement, and may well pave the way for further syntheses of biologically active polypeptides.

On September 4, at 5 p.m., a somewhat bedraggled Congress assembled in the Salle de Promotion at the University of Montreal for the closing plenary session. The platform party on this occasion included Cardinal Leger, chancellor of the University of Montreal. Dr. C. H. Best, president of the Congress, offered the thanks of the Congress organizers to all the many Canadians who had helped to make the Congress such a success. After speeches from previous presidents, Dr. Best then announced that the Permanent Committee had accomplished its week's work and that an International Union of Physiological Sciences had been formed. The members of the Council of the new Union are Best (Canada) (chairman), Visscher (U.S.A.) (secretary), Adrian (Great Britain), Bykov (U.S.S.R.), Heymans (Belgium), Houssay (Argentine), Kuno (Japan), Lundsgaard (Denmark), Mayer (France), von Muralt (Switzerland), and Weber (Germany).

Dr. Houssay thanked our Canadian hosts on behalf of all the members of the Congress, and Dr. Best announced that the 1956 Congress would probably be held in Belgium, but that confirmation of the invitation was still awaited.

The plenary session was followed by a special convocation of the University of Montreal at which Cardinal Leger, as chancellor of the University, conferred honorary doctorates in medicine on Dr. E. D. Adrian (Cambridge) and Dr. L. Binet (Paris) (*in absentia*). Earlier in the week, at a special convocation of McGill University, the Chancellor, Dr. B. C. Gardner, had conferred honorary doctorates of science on Sir Henry Dale, Dr. E. Lundsgaard and Dr. W. R. Hess, all past presidents of Physiological Congresses. This convocation was held in the open air in Molson Stadium. In an address of thanks after the ceremony, Sir Henry Dale made a plea for "complete and confident freedom of communication" among scientists, and declared that national loyalties are not concerned with, and

need in no way weaken, a common loyalty to the advancement of true knowledge in the sphere of our common interest.

On two evenings during the Congress, members were entertained by the City of Montreal at receptions in the Mountain Chalet on Mount Royal. Mayor Houde was an impressive host, and personally greeted every one of his guests—no mean achievement with a Congress of this size. One afternoon was left free of scientific meetings and was wholly devoted to a programme of excursions in Montreal and its environs.

The Congress proper was followed—with some overlap—by an international meeting of pharmacologists. Two sessions on September 4 were devoted to short communications, and on the following day two symposia were held at MacDonald College. The sun, having baked the physiologists, retired honourably on Saturday, and left the heavens to thunder clouds; the rain which resulted was every bit as whole-hearted as the heat had been. The morning was devoted to a session on the action of drugs at autonomic ganglia, with Dr. J. H. Burn in the chair. Papers were read by W. D. M. Paton (London, England) on types of pharmacological action at autonomic ganglia; R. Wien (London, England) on the relation of chemical structure of compounds to their action at autonomic ganglia; S. Marazzi (Maryland) on the action of adrenaline and the reciprocal action of acetylcholine on autonomic ganglia; N. Ambache (London, England) on autonomic ganglion stimulants; and D. Bovet (Rome) on central effects of ganglionic blocking agents. In the afternoon, the symposium had as its subject the pharmacology of renal tubular mechanisms, and papers were presented by I. Sperber (Uppsala) on competitive metabolism and specificity of renal tubular mechanisms; by J. V. Taggart (New York) on biochemical features and energy experiments of renal tubular transport; by K. H. Beyer (West Point) on factors basic to the development of useful inhibitors of renal transport mechanisms; by R. W. Berliner (Bethesda) on the effect of drugs on renal tubular transport of hydrogen ions and potassium ions; and by H. S. Heller (Bristol) on endogenous influences on renal transport mechanisms. The chairman of this symposium was Dr. A. N. Richards.

To bring the week to a fitting and final conclusion the pharmacologists gave a party in Montreal. The gaiety, nowhere more notably evident than in the after-dinner speeches, probably reflected the relief that it was all over. Thus did the tumult and the shouting die, and, in the silent watches of the night, Montreal was deserted by physiologists who crept away to their laboratories in forty-eight different countries of the world. And so to Belgium in 1956.

W. L. M. PERRY

THE ARMAMENT RESEARCH ESTABLISHMENT

THIS year is being celebrated as the golden jubilee of the oldest organization of its kind in Great Britain, the Armament Research Establishment of the Ministry of Supply. The history of the Establishment is essentially the story of the development of high-explosive munitions as we know them to-day and runs the whole gamut from the lyddite shell and its propellant—the unsatisfactory performance of both of which during the Boer War was largely responsible for the formation of the Establishment—to the atomic bomb.

Previous articles[1] in *Nature* have described the work of the Research Department, Woolwich (as the Establishment was then known), from its inception to the end of the First World War, but did not relate how it came into existence. It is proposed to give here a historical review and, so far as security restrictions permit, to describe some of the more important aspects of the Establishment's work since the date of the previous articles. The review will reflect the growing influence of the scientist in matters of defence and the change in emphasis from chemistry to physics in this field.

There existed in 1890 a Government Committee on Explosives, consisting of Sir Frederick Abel (president), Prof. (afterwards Sir) James Dewar and Dr. A. Dupré (all Fellows of the Royal Society). In February of that year this body reported as follows: ". . . the Committee are continually impressed with the great importance, and indeed the necessity, of . . . experimental investigations such as are carried on by Col. Sébert, who is one . . . of the members of the French Permanent Committee on Explosives, and they venture to urge most strongly the wisdom of so extending the scope of work . . . of the Government Explosives Committee as to add to its members an Artillery Officer having special scientific attainments (such as those possessed by Captain Holden) . . .". In its final report in 1891, the Committee said: "The Committee on Explosives . . . desire to impress upon those who will pursue this work from the point where they leave it, that unremitting systematic scientific investigation and practical experiment will be absolutely indispensable to the maintenance of that position".

On March 19, 1891, the above-mentioned Captain C. Holden, R.A., sent a memorandum to the Assistant Director of Artillery advocating the setting up of a department "free to carry out experiments only, and not trammelled by proof or other work, which has to be done against time". He pointed out that "the present time, the commencement of a new era, with the introduction of cordite, is an opportune one". As a result of these representations, some years later a small experimental establishment was set up at the Proof Butts at Woolwich. It must be emphasized that this establishment was a military one concerned primarily with ballistics, that is, gun pressures and shot velocities, and that no scientists were employed.

On April 6, 1900, Major F. L. Nathan, Superintendent of the Royal Gunpowder Factory, in a report to the Chief Superintendent of Ordnance Factories, said that he had "ventured to point out to the Director General of Ordnance on 31 March 1900 that our War Office is not abreast of those of foreign powers as regards machinery for systematic study in connection with explosives for military purposes and to suggest to him the desirability of appointing a small committee of experts to direct experiments and researches, and a staff for carrying them out".

On April 12, 1900, the Admiralty wrote to the Under-Secretary of State, War Office, stressing the urgency of obtaining a better propellant than the

current form of cordite and expressing "their great disappointment at the very little progress made during the past year, as shown by the Annual Report of the President, Ordnance Committee. . . . They hope Lord Lansdowne may see fit to . . . expedite matters, either by the appointment of a special Committee or by an increase in War Office staff. . . . My Lords will be prepared to share in the cost of such extra staff or Committee". On April 19, Major Holden (as he then was) in his capacity as Superintendent of the Royal Gun Factory, also in a report to the Chief Superintendent of Ordnance Factories, suggested means for carrying out trials on propellants; in this report he referred to his proposals of nine years before. On April 21, the Chief Superintendent of Ordnance Factories forwarded Nathan's and Holden's reports to the Director General of Ordnance, who had asked him to ascertain their views on his (the Director General's) proposals for comparative trials between cordite and other smokeless powders. The Chief Superintendent of Ordnance Factories said that he agreed with the two officers that the only way of obtaining a better propellant than cordite was to go into the subject systematically from the beginning, starting with closed-vessel experiments and proceeding to rifles and guns. He recommended a small scientific committee to work at the problem "from day to day till the end was achieved".

On April 30, 1900, the Secretary of State informed the Director General of Ordnance that it had been decided to appoint such a Committee, and this body, known as the Explosives Committee, was set up in May of that year with Lord Rayleigh as president, and Sir Andrew Noble, Mr. R. B. Haldane (later Lord Haldane), Sir W. C. Roberts-Austen and Sir William Crookes as members. The Committee was to report to the Director-General of Ordnance, at the War Office, and its terms of reference were as follows:

"To carry out trials with a view to ascertaining what are the best smokeless propellants for use in existing guns of all natures and in existing small arms.

"To report as to whether any modification in the existing designs of guns is desirable, with a view to developing to the full the powers of any propellant which may be proposed.

"To carry out trials with a view to obtaining a high explosive for shells which can be fired from all natures of guns and howitzers with as much safety as lyddite, with greater certainty of detonation, and with greater explosive effect".

One of the first actions of the Explosives Committee was to recommend to the Director-General of Ordnance that a separate experimental establishment should be formed as soon as possible, to do original research on explosives and steels. The recommendation was accepted, and the War Office and Admiralty agreed to share the cost. Land was secured for the new establishment by extending the eastern boundary of the Royal Arsenal, Woolwich, in 1902, and a laboratory, an explosion chamber, a nitrating house and other facilities were ready for use in 1903 and are still in use to-day. It is this year, 1903, when the preliminary organization had been completed and the facilities provided were put into operation, that has been taken as the date of birth of the establishment.

Meanwhile, the Committee had arranged for the appointment of a young organic research chemist, Dr. O. J. Silberrad, who took office in January 1902 and who very soon afterwards became superintendent of chemical research to the Committee. Silberrad's first main task was to equip the new laboratory, and he was sent to Germany to study similar establishments there.

Under Silberrad's energetic guidance, a small staff of chemists applied themselves to improving propellants and to eliminating the causes of failure of our lyddite shells to detonate properly. The latter end was achieved by developing the use of the explosive trinitrophenyl-methyl-nitramine, which is still used to-day as the intermediary between detonator and main filling, under the name of tetryl.

The work on propellants included research into means of eliminating flash and into methods of manufacture requiring much less acetone.

Systematic research into metallurgical problems connected with armament may be said to have been initiated when Dr. H. Moore was appointed as chief metallurgist to the Chemical Research Department, as the Establishment was then known, in 1904; plans for a separate metallurgical laboratory had been submitted two years earlier.

The Explosives Committee ceased to function in 1906, having in the six years of its existence not only caused the Establishment to be formed but also through it laid the foundation of the modern design of 'conventional' high-explosive munitions. The Explosives Committee was succeeded by the Ordnance Research Board—not to be confused with the Ordnance Board—which sat under the presidency of Major-General D. D. T. O'Callaghan, only Sir William Crookes from the Explosives Committee retaining a seat on the new body. The Ordnance Research Board existed for only about a year before it was merged with the Ordnance Committee, as the present Ordnance Board was then called.

Shortly after the Explosives Committee was disbanded, Dr. Silberrad resigned; he was succeeded as superintendent by Dr. R. Robertson, who was appointed early in 1907 and who remained with the Establishment for the next fourteen years until, as Sir Robert Robertson, he resigned his post of director of explosives research to become Government Chemist.

In April 1907 a radical change took place. The Chemical Research Department and the Proof and Experimental Establishment at Woolwich, which had been concerned with the proof of guns since the seventeenth century, were amalgamated to form the Research Department, Woolwich, under a military superintendent, Major J. H. Mansell, R.A. The Superintendent reported to the Master General of Ordnance through the Director of Artillery. Dr. Robertson became assistant superintendent (chemical research), and Captain Howarth, R.A., assistant superintendent (mechanical research). Dr. Moore, however, assumed the latter office a year or two afterwards. Thus began the direct Service control of the Establishment, which was to continue until 1942, the Service heads being drawn alternately from the Army and the Navy.

Under Silberrad, Robertson and Moore, the scientific work of the Establishment was put on a firm basis, with the results, so far as the first twenty years are concerned, described in the articles referred to earlier.

In the early years of the inter-war period, about 150 scientists were employed in four directorates: Explosives Research (Dr. G. Rotter), Ballistics Research (Dr. (now Sir) Alwyn Crow), Metallurgical

Research (Dr. H. Moore and, from 1932, Dr. R. H. Greaves) and Radiological Research (Mr. V. E. A. Pullin). Much effort at this time was devoted to solving problems thrown up by the First World War, notably the need for stabilizing the older types of cordite and nitro-cellulose powders which, owing to the inclusion of small particles of foreign matter, particularly sulphur, were liable to explode spontaneously; the loss of the battleship *Bulwark* in Sheerness Harbour was probably a result of this serious defect. The cause of such explosions was found to be heat developed at corrosion spots caused by the inclusions; the remedy was to replace all or part of the mineral jelly in the cordite by carbamite, that is, *sym.* diphenyl diethyl urea.

War-time cordites were irregular in dimensions, and therefore in ballistics, owing to the use of volatile solvents in their manufacture and the consequent need for long periods of stoving. By developing a solventless cordite, the Department was able not only to produce sticks of uniform size but also to introduce such checks in manufacture as to enable the energy content to be accurately controlled. The need for expensive gun proof was thereby very much reduced. Simultaneously with these steps to improve propellants, there was instituted a system of '100 per cent surveillance', using specially developed test-papers, of the large stocks of potentially dangerous cordite in all parts of the world.

These improvements in propellants marched hand in hand with advances made by the Department in the science of ballistics, which enabled full use to be made of their potentialities. Thus, not only in ballistic theory but also in ballistic instrumentation, notable progress was made, including new methods of measuring the pressure and strain in guns, and the velocity of projectiles. The Ballistics Directorate was also busy studying the controlled burning of cordite, enabling cordite engines to be used for such non-lethal purposes as the launching of aircraft and the starting of turbine engines. An important development arising from these studies was the anti-aircraft rocket, propelled by cordite; this was the subject of intensive research from 1935 onwards. Its potentialities had been largely established by 1938, in which year prototypes were produced and tested in Jamaica. As a result, a new establishment, the Projectile Development Establishment, under Dr. Crow, was formed in 1939 to develop them for use in the Services. Dr. Crow was succeeded as superintendent of ballistics research by Dr. C. A. Clemmow.

In the high-explosives field, the inter-war years saw the production by the Research Department of a new filling for armour-piercing shell and a delay-action fuze to go with it, thus providing for the Navy a shell which would not detonate harmlessly on impact with a ship's side, as happened with many British shells at the Battle of Jutland, but would penetrate before detonating.

Meanwhile, in the organic branch, the search was going on for a more powerful high explosive than TNT for shell and bomb fillings. After careful and extensive examination of some hundreds of possible compounds, choice was narrowed down to two, tetranitropentaerythrite (PETN) and *cyclo*trimethylenetrinitramine (cyclonite or RDX). Of these, RDX was finally chosen and, in admixture with desensitizing agents—it was too sensitive to be used alone—was widely used in the Second World War, forming the basis of the torpexes, minols and other fillings used in shells and bombs and of the plastic explosive used by the Royal Engineers for demolitions and for sabotage purposes.

In the metallurgical field, the Research Department built up a name for itself through various fundamental researches, many of which had industrial as well as armament applications. Some of the basic work was done with the assistance of grants from the Department of Scientific and Industrial Research. Of the outstanding subjects of investigation in the period under review may be mentioned the improvement of gun forgings to give higher yield strength, temper-brittleness of alloy steels, erosion and wear of gun barrels, and season-cracking of brass and its prevention. Researches in conjunction with the British Non-Ferrous Metals Research Association led to the development of the aluminium–brass condenser tube and the ternary lead alloys for cable sheathing. Much work was also done by the Department on electrodeposition repair processes, which led to the use of electrodeposition for repairing the liners of worn guns and for increasing the life of new guns, with enormous gains in economy.

Radiographic methods were first used in armament research in 1917, and the period between the two World Wars saw the development of radiological methods as an established procedure for investigation and inspection. Mobile sets were constructed for the examination of heavy steel castings and welded structures for the Admiralty, and explosives and propellants were examined for cavities and fissures. Magnetic methods were introduced for the detection of fine cracks in steel forgings and castings. Attention was also paid to X-ray crystal analysis methods of determining grain size and the extent of annealing and cold work.

In this period also, notable advances were made in pyrotechnics, a field in which the Research Department was, and still is, pre-eminent.

When war broke out in 1939 the immediate problem to be faced was shortage of supplies, and the Department's main task was to alleviate or remove production difficulties and to give advice to the Services and the ordnance factories. These tasks were to some extent rendered easier by the planned dispersal of the staff on the outbreak of war to some thirty outstations at ordnance factories, universities, technical colleges and country mansions; but in other ways this dispersal caused grave dislocation.

In 1942, however, following a recommendation of the Guy Committee, reorganization and a degree of recentralization took place. Responsibility for the Research Department had passed in 1939 from the War Office to the newly formed Ministry of Supply, and it was a logical step, and a recognition of the place of the scientist in modern war, that the Guy Committee should also recommend that the direction of the Department should be vested in a civilian scientist. Prof. (now Sir) John Lennard-Jones was appointed chief superintendent (armament research) in that year, and the headquarters of the Armament Research Department, as the Department was renamed (it assumed its present title in 1948), was moved from its evacuation station at Shrewsbury to Fort Halstead, alongside the Armament Design Department. It is interesting to note that the new station had originally been built for the Research Department's daughter establishment, the Projectile Development Establishment, which meantime had moved to Aberporth in Wales.

Thus the wheel had moved full circle, and after thirty-five years a scientist was again at the head of

the Department's affairs. That this is proper in existing circumstances cannot be denied; but tribute must be paid to the efforts of a series of enlightened Service chiefs who, often in the face of opposition, upheld the cause of the Department and its work.

The achievements of the Second World War cannot all be recounted, for obvious reasons, but mention can be made of the incendiary small-arms ammunition, using the Research Department's filling, which was so effective in the guns of the Hurricanes and Spitfires in the Battle of Britain; and of the various hollow-charge projectiles, which were based on the fact (the Neumann or Monroe effect) that an explosive charge which is coned out at its forward end has, rather paradoxically, much greater penetrative effect against a target than a cylindrical charge.

The inferiority of British tank armament, in the early and middle stages of the War, to that of the Germans is well known; but it may not be so well known that the position was reversed when the British 'sabot' projectile, developed in collaboration with the Armament Design Department, came into use and drew from the War Office a telegram "One shot—one tank—can't miss", after the D-Day landings. The principle of the 'sabot' is that a small but heavy and hard shot is centred in a gun of larger diameter than the shot by means of a segmented and therefore weakened collar (the 'sabot') which, when the combined projectile emerges from the gun, breaks up and separates from the shot through the action of the centrifugal force due to the spin. The shot, with the very high velocity imparted to it by the large gun, and a correspondingly high penetrative power, then proceeds alone on its mission.

The need for large blast bombs for the attack on Germany led to the development of the 'aluminized' explosives, formed by mixing high explosive with powdered aluminium, which greatly increases the blast effect. Bombs with such explosives were used in the attacks on the Ruhr dams and the battleship *Tirpitz*. Target indicators and photoflash bombs were also developed for the R.A.F.

For the inspection departments and firms engaged on munition production the metallurgical branch provided advice and assistance on a multitude of problems.

Much of the work of an establishment like the Armament Research Establishment is inevitably of a consultative and advisory nature, and this is particularly so where safety problems arise. It is largely due to the accumulated experience of the Establishment that British munitions are second to none in safety of handling and operation.

The investigation of the cause of accidental explosions often involves the scientific and other staff concerned in situations of extreme personal danger. Such duties have never been shirked, and it may be mentioned that just after the War Dr. G. Rotter was awarded the George Medal and Mr. S. W. Maxted was appointed M.B.E. for extremely hazardous and protracted underground work following a very large explosion in an ammunition depot. More recently, five members of the staff have received the Queen's Commendation for Gallantry in connexion with an explosion in Woolwich Arsenal. During the War, mobile teams radiographed unexploded enemy bombs and fuzes in order to assist the bomb disposal units in their hazardous task. Mr. W. J. Wiltshire, Mr. D. E. Barnes and Dr. J. A. T. Dawson received the George Medal for gallantry in the course of this work.

A most important war-time development was the creation in 1943 of a branch for theoretical research, comprised first of all of mathematicians but recently expanded to include physicists and engineers to operate new facilities erected at Fort Halstead for the study of problems in aerodynamics and hydroballistics. To-day the Applied Mathematics and Mechanics Division possesses a supersonic wind tunnel, a cavitation tunnel, a tank for studying the motion of projectiles on and after entry into water, and a high-speed electronic computer with which it will provide a computing service for the whole Ministry as well as for the Establishment.

The Establishment's war effort on both occasions was increased by the temporary employment of scientists drawn from the universities or elsewhere, and many such who are household names in the scientific world have at one time or another been colleagues of the regular staff.

Just as after the First World War, so after the Second, there were changes in the organization. Thus in 1946 the mainly chemical aspects of the Establishment's work were detached and assigned to a new body, the Explosives Research and Development Establishment at Waltham Abbey, which thus became the Armament Research Establishment's second daughter establishment. In that year, too, Prof. Lennard-Jones, who had been knighted for his services, resigned and was succeeded by Dr. (now Sir) William Penney as chief superintendent. Shortly afterwards, the Department was given the vital task of developing Britain's first atomic bomb, under the code-name of 'H.E.R.' (High Explosives Research). As the project grew, it became necessary once again to form a separate establishment, the Atomic Weapons Research Establishment, from the Armament Research Establishment, which this time was called upon to make an even greater sacrifice than on the two previous occasions, since it gave not only its chief superintendent and a large number of its most experienced staff to the new body but also buildings, including its headquarters offices. New headquarters were set up at Woolwich, where some sections which could not be evacuated had remained throughout the War.

When the new buildings for atomic work at Aldermaston are finally completed, the laboratories at Fort Halstead erected for 'H.E.R.' will become available to the Armament Research Establishment, which will therefore recover something of what has been lost; but it will be some time before the inroads made into the staff are made up and the still vitally essential work on more conventional weapons can proceed with full effect.

Under the present chief superintendent, Dr. H. J. Poole, the Establishment is, however, now building up again as rapidly as conditions permit. With its programme of basic researches in the fields of mathematics, metallurgy, physics, chemistry and ballistics; with close contacts with the universities through common membership of committees of the Ministry's Scientific Advisory Council, and a policy of permitting publication whenever security considerations permit, it can offer a satisfying and useful career to scientists in any of the fields mentioned, as well as in engineering. The Establishment looks to the next fifty years with confidence.

At a dinner to celebrate the golden jubilee of the Establishment, held at the Goldsmiths' Hall on November 27, the Minister of Supply, the Right Hon. Duncan Sandys, was the principal guest.

[1] Robertson, *Nature*, **105**, 710 and 743 (1920).

OBITUARIES

Prof. T. Thunberg

With the death of Torsten Thunberg on December 4, 1952, there passed an investigator whose name was known to generations of physiologists and biochemists, and whose 'Thunberg tube' has served a valuable purpose in the study of dehydrogenase reactions. It was undoubtedly as a biochemist that Thunberg made his major contributions to science.

Born in 1873, Thunberg, after training in medicine, became a demonstrator for one year in the Institute of Physiological Chemistry at Uppsala under Olof Hammarsten, and for two years under Frithiof Holmgren, in the Institute of Physiology. In 1897 he was appointed temporarily as reader in physiology at Uppsala, in which post he was confirmed in 1901 at the early age of twenty-eight. After the death of Magnus Blix in 1904, Thunberg became the temporary occupant of the chair of physiology and embryology at Lund, and in the following year he was appointed substantively to the chair of physiology, a post which he retained until his retirement in 1938. On his retirement he was appointed professor emeritus, and he continued to make contributions until the time of his death, his last paper being published early this year.

Although in his early years Thunberg's researches extended as far as the physiology of the senses, including colour blindness, it was for his investigations on dehydrogenases, and on the metabolic significance of citric acid, that he is best known. When he began his studies on intermediary metabolism, little was known about the mechanism of oxidation within the cells. In 1885 Paul Ehrlich's book, "Das Sauerstoffbedürfnis des Organisms", described the staining of tissues by the *intra vitam* injection of dyes such as methylene blue, and stated that some tissues could reduce suitable injected dyes to colourless leuco-bases; but little came of these observations at the time. In 1912 Wieland showed that organic substances can be oxidized by the removal of hydrogen in the presence of a catalyst, and that the hydrogen could be taken up by suitable acceptors, such as methylene blue, which were thus reduced to the colourless leuco-base. Thus, the oxidation of ethanol to acetic acid could be formulated in terms of the activation and removal of hydrogen atoms. In his own studies, Thunberg had investigated the capacity of animal tissues to oxidize acids such as acetic, propionic, oxalic, malic, succinic and citric acids, and it was perhaps intuition which led him to choose, from all those available, acids such as succinic and citric, the especial importance of which in metabolism is now clearly recognized.

In 1910 Thunberg found that the addition of succinate to minced muscle resulted in an increase in oxygen uptake, and later integrated his own with Wieland's discoveries in propounding the idea of a specific hydrogen-activating, chain-forming enzyme system in the oxidation of succinate. A dehydrogenase, such as succinic dehydrogenase, could activate hydrogen atoms in its substrate to bring about a reaction which otherwise could not be observed, namely, the reduction of methylene blue to the colourless leuco-base; this colourless leuco-base could in turn be reoxidized to methylene blue by atmospheric oxygen. The introduction of the terms 'hydrogen donator' and 'hydrogen acceptor' in this connexion were of the widest significance, and opened up the possibility of the existence of a multitude of hitherto unsuspected dehydrogenases. The ideas that developed from this work appeared to be contrary to that of Warburg's 'respiratory enzyme' in some respects; but later Warburg's own 'yellow enzyme', a hydrogen-carrying flavo-protein, helped to bridge the gap, and to-day Thunberg's concept of hydrogen transport from one system to another lies at the root of modern views on oxidative metabolism.

In 1910 Thunberg suggested that citric acid represented a normal intermediary in metabolism and he was afterwards able to map out the occurrence of citric acid in animals and man. The recent development of the citric acid cycle, first through the researches of Szent-Györgyi on the catalytic significance of succinic acid in biological oxidation, and then through the addition of tricarboxylic acids to complete the cycle, which was the work of Krebs, bears witness to the far-sightedness and soundness of Thunberg's ideas. With Thunberg's death biochemistry has lost one whose contributions are securely placed within the foundations of modern views on intermediary metabolism in general and of the mechanism of cellular oxidation in particular.

Vol. 30, Supp. 111, of *Acta Physiologica Scandinavica* contains an obituary notice of Thunberg with a bibliography of his papers. F. G. Young

Mr. L. St. L. Pendred, C.B.E.

The news of the death on November 20 at Twickenham of Loughnan St. Lawrence Pendred, for forty years the editor of *The Engineer*, will be read with regret by engineers all over the world. Together with *Engineering*, *The Engineer* is read wherever engineers congregate, both journals being known for their high professional standard and the sense of responsibility shown by a succession of able editors. Founded in 1856 by Edward Healey, *The Engineer* was edited for a short time by the brilliant but eccentric American engineer Zerah Colburn (1832–70), who in 1866 founded *Engineering*. Colburn was a nephew of the famous American 'calculating boy', Zerah Colburn (1804–40), and is sometimes confused with him. Colburn's connexion with *The Engineer* ceased in 1864, and shortly afterwards Vaughan Pendred (1836–1912) was appointed editor. A native of Barraderry, Co. Wicklow, Vaughan Pendred in 1862 had married Marian Loughnan, of Crohill, Co. Kilkenny, and a year or two later had settled in England, obtaining through Colburn an appointment in a works in Staffordshire. A classical scholar, a lover of mechanics and a born journalist, he became first the editor of the *Mechanic's Magazine*, and then in 1865 editor of *The Engineer*, a position he held until his retirement in 1905.

Loughnan Pendred was one of Vaughan Pendred's three sons. Born on November 23, 1870, he received his technical education at the Central Institution, South Kensington, and Finsbury Technical College, where he came under the influence of Silvanus Thompson, John Perry and H. E. Armstrong. Leaving college, he served an apprenticeship with Davey, Paxman and Co., of Colchester, and gained further experience in Belgium and France, and during 1893–96 he worked in the ordnance department of Armstrong's great works at Elswick. In 1896 he joined the staff of *The Engineer*, and nine years later succeeded his father as editor. Long a member of the Institution of Mechanical Engineers, he was president during 1930–31 and represented the

Institution at the jubilee meetings of the American Society of Mechanical Engineers. In 1934 he delivered the Thomas Lowe Gray Lecture of the Institution, taking as his subject "A Survey of Ships and Engines".

Having guided the fortunes of *The Engineer* during two world wars and the great depression of the '30s, Pendred resigned his editorship in 1946 and was succeeded by his second son, Benjamin Pendred, who had joined the staff in 1931. During the First World War, Pendred was editor of *The Ministry of Munitions Journal*, and for this and other services to engineering, in 1934 was created C.B.E. The Institution of Mechanical Engineers also made him an honorary member.

Always interested in the history of engineering, Loughnan Pendred played an important part in the inauguration in 1920 of the Newcomen Society, and it was at a dinner given by him to some of its founders, at the Savage Club, then housed in the Adelphi, that the name of Thomas Newcomen was adopted for the new Society. Pendred was one of the original members of council and during 1922–24 and 1928–30 served as president; on October 26, 1923, delivering a stimulating address on "The Value of Technological History". Among his other contributions to the *Transactions* of the Society was a scholarly address given in Dartford Parish Church on the occasion of the commemoration on April 23, 1933, of the centenary of Richard Trevithick. Other societies with which he was connected include the Iron and Steel Institute, the Junior Institution of Engineers, of which he was an honorary member, and the Institution of Engineers-in-Charge, of which he served as president. In an appreciation of Pendred when he retired, Mr. G. E. Chadwyck-Healey, a grandson of Edward Healey, wrote: "I count myself fortunate in having had so kindly, wise and steadfast a friend". There are others who will feel the same.

Edgar C. Smith

Mr. A. B. Broughton-Edge, M.B.E.

Mr. Arthur Broughton Broughton-Edge, who died on October 8 after an illness which dated from 1940, was a man of very wide interests, demonstrated by his membership of the Institution of Mining and Metallurgy, the Chemical Society, the Mineralogical Society, the Geological Society and the Geologists' Association. His main concern, however, was in geology and the use of geophysical methods in the search for minerals, and in this latter branch he was one of the early pioneers. Born on March 16, 1895, and educated at Bradfield College, Berks, he joined the University and Public Schools Corps at the outbreak of the First World War. Later, commissioned in the Royal Artillery, he saw active service in France, Salonika, etc., with an Indian Mountain Battery. He was invalided to England after an injury in Greece and spent the last part of the War investigating poisonous gases and, as a result, himself suffered from their effects. This phase of his career, for which he was made M.B.E., may well reflect his early interest in chemistry.

In 1918, however, Mr. Broughton-Edge entered the Royal School of Mines and studied geology, in particular the geology of mineral deposits, under Prof. C. G. Cullis, obtaining an A.R.S.M. in 1921 and a B.Sc. in 1922. As a student he visited Cyprus and was a joint author with Prof. Cullis of an authoritative work on "The Cupriferous Deposits of Cyprus", ultimately published in 1926. Although he studied numerous types of mineral deposits in many parts of the world and was active in the examination of old mineral fields of Great Britain, he will be mainly remembered for his early investigations into the use of geophysical prospecting methods in the search for minerals. In 1925 he was experimenting in Africa with electrical methods, and this valuable experience naturally led in 1928 to his appointment as director of the Imperial Geophysical Experimental Survey in Australia. The report of this survey, which was jointly financed by the Empire Marketing Board and the Australian Government, did much to remove the mystery which surrounded the procedures at that time and placed them on a sound scientific basis.

In 1935 he married Muriel Docea Pullman, who nursed him devotedly during his illness until her untimely death in 1947. Mr. Edge's fortitude during this period was outstanding and, despite his obvious handicaps, he investigated the uses of the microscope for special mineralogical problems, the results of which will be published posthumously.

Mr. Robert Donaldson

The sudden death on November 5 of Robert Donaldson has deprived physical optics of one of its well-known workers. Born in 1904, he obtained a first in his M.A. in the University of Edinburgh and, after two years as demonstrator in the Department of Natural Philosophy there, went to the National Physical Laboratory in 1928. He was, in those days, as much a mathematician as a physicist and was specially fitted for the post of assistant to John Guild, then conducting his classical researches in the measurement of colour. This early work set the pattern for all that followed for, except during the war years, when he participated in the general work of the Light Division of the Laboratory, Donaldson was primarily occupied with the field of colorimetry, heterochromatic photometry and spectrophotometry.

In 1933 he became head of the colorimetry section of the Division and made outstanding contributions to the subject by the design of instruments and the development of new techniques; by investigating problems arising from the commercial introduction of new illuminants and colorants, for example, fluorescent lamps and paints; by providing the experimental data, apparatus and methods for new applications of colour in the medical field, such as colorimetric hæmoglobinometry and spectrophotometric tests for vitamins; and by the improvement of the standardizing procedures called for by the many specifications now governing the supply of lights and filters for rail and road signalling, marine and aerial navigation, aerodrome lighting, etc. Donaldson had a special aptitude for getting to the roots of a research problem, and this is well shown by a few examples of some of the instruments which bear his name.

The first trichromatic colorimeter designed at the National Physical Laboratory was intended primarily for the researches in the Laboratory which led to the establishment of the present international system of colour standardization. It required a supply of direct current and so proved inconvenient for use in industrial laboratories, many of which had only a public supply of alternating current available. Donaldson designed a colorimeter in which the blending of the trichromatic stimuli is effected by an integrating sphere, and which can be used with either A.C. or D.C. supply. This instrument is now the most widely

used trichromatic colorimeter in the English-speaking countries.

A trichromatic colorimeter, though the fundamental instrument for colour measurement, gives results which depend to an appreciable extent on the colour vision of the observer. To minimize these variations, it has to employ a small visual field, which is a disadvantage for industrial or commercial applications. To meet this difficulty, Donaldson designed an instrument on the same lines as his trichromatic colorimeter but with three additional matching colours, making six in all, which when calibrated and used in the proper way gives results characteristic of the C.I.E. 'standard observer', unaffected by any but very gross visual abnormality of the actual user. It can be used with a large matching field, giving much greater precision than the small field of the trichromatic instrument. This colorimeter has proved most valuable in work at the National Physical Laboratory and has recently been made available commercially.

For many purposes, particularly in a standards laboratory, a colorimeter in which the eye of a human observer is replaced by a photo-cell or other detector of light is of great value. It not only avoids fatigue of observing staff but also gives results which are not limited in precision by visual sensitivity or affected by visual abnormalities. The physical detecting system must, of course, be arranged to evaluate light in exactly the same way as the accepted 'standard observer'. There are several ways of doing this—by filters or by templates fitted in a spectrometer, the filters or templates being made in relation to the spectral response of the photocell so as to give the required resultant spectral response for the combination. Donaldson designed a template colorimeter before the Second World War but, unfortunately, before it could be constructed the war-time claims on workshop facilities caused abandonment of the project until the return of peace. Other template colorimeters were developed commercially in the meantime; but none of these is capable of the highest class of work. Donaldson's instrument was designed with that end in view. It was constructed after the War and appears to provide a complete solution to the problems of exact physical colorimetry and heterochromatic photometry.

In addition to the foregoing, Donaldson was responsible personally or in a supervisory capacity for the design and development of numerous instruments and devices required for use in the National Physical Laboratory, such as photoelectric spectrophotometers for the visual and ultra-violet ranges, comparators for the calibration of hæmoglobin test-tubes, double monochromators with single optical train, and so on, including, in collaboration with Stiles, the design of the multiple spectroscopic colorimeter now under construction for the forthcoming redetermination of the properties of the 'standard observer'.

At the invitation of the Medical Research Council he collaborated with a team of pathologists and biochemists in setting up a system of standardized colour tests for hæmoglobin determinations. He was responsible for the investigation of the relation between the oxygen-carrying capacity of hæmoglobin with its iron content and spectral absorption. His results, obtained from an analysis of blood samples from representative groups of male and female subjects, have established a norm for the hæmoglobin content of human blood which is now the standard by which all test apparatus is calibrated.

Donaldson's scientific abilities were recognized a few months ago by his special promotion to the grade of senior principal scientific officer. His personal gifts were rewarded by the respect and affection of all his colleagues; modest and unassuming himself, he had a keen sense of humour and an understanding for the failings of others. His tastes were simple and he had a true Scotsman's delight in a game of golf. His sudden death has robbed his colleagues and many friends of one who merited their affection and esteem.

L. A. Sayce

We regret to announce the following deaths:

Dr. Herbert E. Ives, member of the U.S. National Academy of Sciences, formerly of the Bell Telephone Laboratories, aged seventy-one.

Dr. T. W. Lumsden, director of cancer research in the London Hospital, 1930–42, aged seventy-eight.

NEWS and VIEWS

P. P. E. Roux (1853–1933)

Born at Confolens, Charente, a century ago, on December 17, 1853, Pierre Paul Émile Roux began his medical studies at Clermont-Ferrand, where he attracted the attention of Émile Duclaux, whom he was to succeed as director of the Pasteur Institute at Paris in 1904. His friendship with Pasteur began in 1878, when he started working in the old laboratory of the École Normale Supérieure. Like his master, Roux possessed a real genius for finding brilliant men and drawing out their best qualities. Self-effacing and hating publicity, he gave many of his most enduring contributions to the world under the name of a colleague. He amplified Pasteur's work on attenuation, chicken cholera, vaccination of sheep and cattle against anthrax, and rabies. In collaboration with Elie Metchnikoff, he succeeded in inoculating anthropoid apes with syphilis, and introduced the prophylactic use of calomel ointment. In 1888, Alexandre Yersin and he isolated the diphtheria toxin by passing a culture through a porcelain filter, thus paving the way for Emil von Behring's discovery of the antitoxin. Roux's announcement in 1894 at the International Congress of Medicine in Budapest that the antitoxin possesses both prophylactic and therapeutic value caused a sensation in medical and lay circles. As a teacher, Roux was lucid, concise and graphic, and pupils from all over the world attended his bacteriology courses. His numerous scientific honours included the foreign membership of the Royal Society in 1913 and the Copley Medal in 1917. Though in his later years everyone knew the tall, gaunt, ascetic man with the hollow cheeks and sallow complexion, who occupied the most honoured place in the world of bacteriology, few really knew him well. A sufferer from chronic pulmonary tuberculosis for thirty years, Roux died on November 3, 1933. His obituary in *Figaro* had been written by his colleague, Albert Calmette who died a few days before him.

Jubilee of Powered Flight

Orville Wright's first successful powered flight occurred fifty years ago on December 17, 1903. Man's age-old ambition to fly had culminated in considerable aeronautical activity during the last quarter of the nineteenth century. Ballooning had been well established before this, and there remained the mastery of 'heavier-than-air' flight. Lilienthal and Pilcher had made precarious flights in gliders of various bird-like shapes and had ultimately perished. Octave Chanute, president of the American Society of Civil Engineers and builder of the first bridge over the Missouri, had invented—and flown—the biplane arrangement of the wings of his glider. Lanchester and Langley had flown stable model 'aerodromes', the latter's including steam-powered tandems which were capable of speeds in excess of 30 m.p.h. However, Langley's man-carrying machine had fallen into the Potomac River immediately after being catapulted from a houseboat on December 8, 1903. This concluded the heartbreaking story of seventeen years of scientific effort by the secretary of the Smithsonian Institution and his associates. It is evident that some of the Wrights' contemporaries were very close to success at that time, but none of them had the Wright brothers' combination of the gifts of scientific appreciation of evidence, design ingenuity and ability to make apparatus with their own hands. They carefully analysed Lilienthal's results and then gave their attention to three problems: the provision of adequate lift with stability, of thrust and of control. They studied the first with a home-made wind tunnel and built their own 12-b.h.p. internal combustion engine. They developed their own propellers and achieved the then remarkable efficiency of 66 per cent. Their wing-warping system of lateral control was a crucial advance upon what had gone before, but it is the overall achievement that these men are best known for. They were mechanics in the best sense of the term.

A special exhibition commemorating the jubilee will be opened at the Science Museum, London, S.W.7, on December 15 and will remain on view for about three months (admission free). Models, books, aeronautical relics and diagrams will be displayed illustrating early contemporary thoughts and ideas on powered flight by a man-carrying machine, and how this was ultimately achieved by the Wright brothers. The *National Geographic Magazine* of December contains an article on the work of the Wright brothers with several historical photographs.

Natural Philosophy at Edinburgh: Prof. M. Born, F.R.S.

Prof. Max Born, who has recently retired from the Tait professorship of natural philosophy at the University of Edinburgh, succeeded Sir Charles Darwin in that chair in 1936, when the latter was appointed Master of Christ's College, Cambridge. He had previously been *Professor Ordinarius* at Göttingen, where he was head of the world-renowned school of theoretical physics, which with Bohr's Institute for Theoretical Physics at Copenhagen played such a large part in the development of the quantum theory and its applications in the period between the two World Wars; while headed by Prof. Born it was, like Bohr's Institute, a place of pilgrimage for all those working in this field of theoretical physics. In 1933 the rising tide of Nazism in Germany drove him to leave Göttingen, and he went to Cambridge as lecturer in the Faculty of Mathematics; he was appointed Stokes lecturer in applied mathematics in 1934, and held this post until his appointment to Edinburgh. He was elected a Fellow of the Royal Society in 1939. Both by his own work and through the stimulus, encouragement and help which he gave to others, Prof. Born has had considerable influence on progress in various branches of theoretical physics, notably in the dynamics of crystal lattices, in quantum theory both in its general aspects and in its applications to particular systems, and latterly in the theory of the structure and properties of liquids.

Prof. N. Kemmer

Prof. N. Kemmer, who succeeded Prof. Born at Edinburgh at the beginning of the current academic year, was, like his predecessor, Stokes lecturer in applied mathematics at Cambridge before his appointment to Edinburgh. He has studied abroad for a considerable period, and holds the degree of D.Phil. of Zurich. He was appointed a lecturer in the Faculty of Mathematics at Cambridge in 1946, and was elected to a fellowship at Trinity College in the same year; he was appointed Stokes lecturer in 1949. He has been a member of the Board of the Faculty of Mathematics, and is interested both in teaching and research in mathematical physics. His main lines of research interest are quantum theory and its applications, especially nuclear theory and, more recently, quantum field theory and quantum electrodynamics. In this field he has been one of the leaders of a vigorous group of investigators at Cambridge, and has had a number of research students working under his direction.

Geology and Mineralogy at Trinity College, Dublin: Dr. W. D. Gill

Dr. W. D. Gill has recently been appointed to the chair of geology and mineralogy in Trinity College, Dublin, which became vacant last year on the death of Prof. L. B. Smyth (see *Nature*, 171, 196; 1953). Graduating in 1938 from the University of Leeds with first-class honours in geology, Dr. Gill joined the Attock Oil Co., Burma, and, working as a micro-palæontologist and field geologist, was a member of a small team which discovered many new prospects for oil. Specializing on the Siwalik Series in the Northern Potwar, he also discovered new foraminifera in Eocene formations. He joined the staff of the University of Nottingham in 1948 and became responsible for the development of photogrammetry in the Department of Geology and the establishment of a flourishing school of research on the micropalæontology of the Jurassic and Cretaceous rocks of Lincolnshire and Yorkshire. Using published and original material, Dr. Gill synthesized the structure and mechanism of mountain building in the frontal Himalayas. He takes to Trinity College, Dublin, a great store of new material and an enthusiasm for geological research in every field of the subject, and especially in structural and stratigraphical studies.

Expansion of the Department of Scientific and Industrial Research during 1954–59

The principal effects of the recent announcement by Sir Ian Heilbron about the future development of the Department of Industrial and Scientific Research (see *Nature*, December 5, p. 1029) will be to enable the post-war plans of the Department to

be completed. Decisions have still to be made on the actual allocations of the increased funds available. The income of the Department is expected to increase by £400,000 during 1954, the present income being approximately £5 million. Subsequent increases will bring the Department's vote to about £6 million by 1959, an increase over the five years of about 20 per cent. Another important change in the financial arrangements for the Department is that money not spent in any given year may, subject to the necessary funds being voted by Parliament, be carried forward for use in the following year. The Department's planning of research will thus be much more flexible than hitherto, when money unspent at the end of the year has had to be surrendered. Recruitment of staff will recommence at the rate of a hundred and fifty non-industrial staff yearly, and about one-third of that number of industrial staff each year. Apart from the afore-mentioned increases, a further sum of £6 million will be available to the Department for use during the period in the erection of new buildings. The original building plan for the Mechanical Engineering Research Organization at East Kilbride, Glasgow, will now be completed, and the new Road Research Laboratory, necessitated by the expansion of London Airport, will now be built, as also will be the new Ship Tank at the National Physical Laboratory, Teddington. The Hydraulics Research Station, Wallingford, the Water Pollution Research Laboratory, Stevenage, and the Radio Research Station, Slough, will be completed.

Parliamentary Responsibility for Atomic Energy

In reply to further questions in the House of Commons on November 26, the Prime Minister said that the Lord President of the Council will be responsible for the government atomic energy establishments from January 1. The Lord President will, therefore, be responsible for ensuring that the results of research in the universities are taken into account in the work of the government atomic energy establishments. Research by the universities is, of course, carried out on their own responsibility and is mainly of a fundamental nature; but the atomic energy organization places contracts with the universities in connexion with specific research inquiries. The Prime Minister had already indicated, on November 19, that when the new system comes into operation questions relating to the responsibilities transferred from the Ministry of Supply to the Lord President of the Council would be answered by the Minister of Works. He now states that the questions of atomic energy cover so wide a field that purely technical and scientific questions only will be dealt with by the Minister of Works, while others may have to be answered by the Foreign Secretary or by himself.

Fluoridation of Water

In a written reply to a question in the House of Commons, the Minister of Health, Mr. Iain Macleod, has announced that the Government has decided to accept the recommendations of the mission which recently visited North America to study the fluoridation of domestic water supplies as a means of controlling dental caries. The Minister, in conjunction with the Minister of Housing and Local Government, who is responsible for public water supplies in England and Wales, and the Secretary of State for Scotland, proposes to arrange for studies to be made in some selected communities of the various aspects of the fluoridation of water supplies before considering whether fluoridation should be generally adopted in Britain. An approach will be made to certain local authorities to invite their co-operation in making these studies.

Yorkshire Dales National Park

The chairman of the National Parks Commission (Sir Patrick Duff) has signed the Yorkshire Dales National Park (Designation) Order; this is the seventh National Park to be designated. The Order will be submitted in due course to the Minister of Housing and Local Government for confirmation. The area, which comprises a total of approximately 680 square miles, lies wholly within the North and West Ridings of Yorkshire. The boundary is broadly similar to that proposed in 1947 in the Hobhouse Report, though certain changes have been made, notably the addition of some 80 square miles in Sedbergh Rural District, including Dentdale and the Howgill Fells. The proposed National Park contains a wide variety of landscape which includes not only the most picturesque parts of the famous Dale country, but also some of the finest limestone scenery in Britain. From Bolton Abbey in Wharfedale, it extends northwards, through Malham with its impressive Cove, and the Gordale Scar—to Ribblesdale and the mountains—Ingleborough, Whernside and Pen-y-Ghent. Continuing northwards through upper Wharfedale with its many charming villages from West Witton to Garsdale Head, the Park extends across to Swaledale and the outskirts of Richmond, and north-west to Arkengarthdale and Bowes Moor.

The Development of Canada

During November 13–14 a conference was held in Quebec city under the title "Canada's Tomorrow". The proceedings of this conference comprised the presentation and discussion of eight papers which surveyed the whole Canadian scene and assessed from a set of rather fundamental points of view the country's position in the world and the possible directions of its future development. The conference had been initiated by the Canadian Westinghouse Company, of Hamilton, Ontario, in celebration of the Company having attained its jubilee manufacturing in Canada, and the conference members, numbering more than three hundred, were the guests of the Company. Church, Government, education, administration, science and industry were represented. The papers and their authors were as follows: "The Canadian People", Dr. B. K. Sandwell, of the *Financial Post*; "Canada's Natural Resources", M. W. Mackenzie, executive vice-president, Canadian Chemical and Cellulose Co., Ltd.; "The Challenge to Science", Dr. R. K. Stratford, scientific adviser, Imperial Oil, Ltd.; "The Contribution of Industry", D. W. Ambridge, president and general manager, Abitibi Power and Paper Co., Ltd.; "The Role of Government", M. Lamontagne, chairman of the Department of Economics, Laval University; "The Challenge to Education", Dr. N. A. M. Mackenzie, president of the University of British Columbia; "Cultural Evolution", Prof. H. Neatby, professor of history, University of Saskatchewan; "Canada in the World", Prof. D. G. Creighton, professor of history, University of Toronto; together with a paper representing a critical summary and assessment based on the papers just mentioned, which had been prepared by Prof. Denis Brogan, of the University of Cambridge, and which was presented at the dinner

with which the conference was brought to a close. On the afternoon of November 12, the day before the proceedings of the conference opened, an honorary doctorate was conferred at a special degree congregation on Mr. H. H. Rogge, president of the Canadian Westinghouse Company, by the University of Laval. It is understood that the papers presented and the discussion on them will, in due course, be published in book form.

Geographical Association: Annual Conference

The annual conference of the Geographical Association will be held in the London School of Economics, Houghton Street, London, W.C.2, during December 30, 1953–January 2, 1954. The meeting will commence with the presidential address, by Dr. O. J. R. Howarth, who will speak on "The Commonwealth in the Geography Syllabus". Besides a number of lectures, there will be three symposia on the following subjects: the place and use of Ordnance Survey maps in the primary school; specialization in sixth forms; and geography in further education. Excursions will be made to the Map Room of the British Museum, the Central Forecasting Office, Dunstable, the Darwin Museum at Down House, Downe, Kent, and to the Port of London Authority. On January 1 at 3 p.m. there will be a joint meeting with the Royal Geographical Society and the Institute of British Geographers at the Royal Geographical Society's House, London, S.W.7 (admission by special ticket only), at which Mr. T. D. Bourdillon and Mr. C. W. F. Noyce will give a lecture on "The Ascent of Everest, 1953, and its Significance". In conjunction with the conference the Association is holding its usual exhibition of books, maps and appliances (including visual aids) for the teaching of geography. Further information can be obtained from the honorary conference organizer, Dr. W. G. V. Balchin, Department of Geography, King's College, Strand, London, W.C.2.

Conference on Embryology and Experimental Morphology

A scientific conference associated with the annual meeting of the Editorial Board of the *Journal of Embryology and Experimental Morphology* will provide embryologists in Great Britain with an opportunity to discuss the latest work of many of their European colleagues. The meetings will take place during January 9–12 at University College, London, and papers will be read by M. Abercrombie, J. Brachet, A. Dalcq, E. Faure-Fremiet, S. Horstadius, F. E. Lehmann, J. Pasteels, Chr. P. Raven, S. A. Stefanelli, S. Toivonen, C. H. Waddington and Et. C. Wolff. On January 11 demonstrations of research material will be given by J. Brachet, A. M. Dalcq, S. M. Manton, P. B. Medawar, D. R. Newth, J. Pasteels, A. Stefanelli and C. H. Waddington. The meetings are open to all biologists, and details of them may be had from Dr. D. R. Newth, Department of Zoology, University College, London.

Lectures on Atomic Energy

The Atomic Scientists' Association and the University of London Extra-Mural Department are arranging a course of six lectures on "Atomic Energy", to be held in the Beveridge Hall, Senate House, Malet Street, London, W.C.1, on successive Wednesdays at 7 p.m., commencing January 20, 1954. The titles of the lectures and the speakers will be as follows: atomic research at Harwell, by Sir John D. Cockcroft, director of the Atomic Energy Research Establishment, Harwell; atomic weapons, by Prof. O. R. Frisch, Jacksonian professor of natural philosophy, University of Cambridge; power from atomic energy, by Prof. F. E. Simon, professor of thermodynamics, University of Oxford; radiation hazards of atomic energy, by Dr. J. F. Loutit, director of the Radiological Research Unit, Harwell; medical uses of atomic energy, by Dr. E. E. Pochin, director of the Department of Clinical Research, University College Hospital, London; and atomic energy and moral issues, by Prof. Kathleen Lonsdale, professor of chemistry, University of London, and Sir George Thomson, master of Corpus Christi College, Cambridge. The fee for the lectures is 10*s*. for the complete course or 2*s*. a lecture. Tickets and further information can be obtained from Prof. J. Rotblat, Physics Department, Medical College, St. Bartholomew's Hospital, Charterhouse Square, London, E.C.1.

Harwell Isotope School: Courses during 1954

The Isotope School at the Atomic Energy Research Establishment, Harwell, which teaches the techniques of using and handling radioactive materials to scientists, directors and industrial research workers, is holding five courses during 1954 on the following dates (the latest date of application is shown in brackets): Course 21, January 11–February 5 (December 12, 1953); Course 22, March 1–26 (February 1); Course 23, August 30–September 24 (August 2); Course 24, October 4–29 (September 6); Course 25, November 15–December 10 (October 18). The School building, which is equipped with the latest apparatus, is outside the security fence; lectures and instruction are given by members of the Harwell staff. Students pay a fee of £40 for the course, and living accommodation can be arranged in the neighbourhood at moderate charges. Applications should be sent to the Isotope School, A.E.R.E., Harwell, near Didcot, Berks.

Overseas Scholarships Scheme of the Federation of British Industries

Dr. W. Abbott, formerly H.M. staff inspector of engineering at the Ministry of Education, has been appointed director of studies in connexion with the overseas scholarships scheme of the Federation of British Industries. Mr. W. V. Jenkins, who has been responsible for the operation of the scheme since its inception, remains as manager. The scholarships scheme now embraces Australia, Chile, Cuba, India, Iran, Pakistan, Peru and the Sudan, and is in process of being extended to other British territories and certain foreign countries, especially in the Middle East. The first two groups of scholars from Latin America, four from Peru and three from Cuba, have recently arrived in Britain and begun their training at engineering works in various parts of the country. Scholars from other Latin American republics are expected shortly. Three more Indian scholars have also begun training, making a total of twenty-six graduates who are receiving their training under the scheme. Six have already returned home after completing their training.

University of Birmingham

The following appointments have recently been made in the University of Birmingham. Dr. J. A. H. Waterhouse, lecturer in human genetics, has been given the title of reader in medical statistics. Dr. P. L. Krohn has resigned his readership in endo-

crinology in order to accept a Nuffield Gerontological Research Fellowship, tenable in the Department of Anatomy; funds are also provided for the salaries of research assistants and the cost of equipment and materials. Dr. E. J. Hamley has been appointed a lecturer in physiology. The following have been appointed to fellowships in the University: P. Reasbeck, Imperial Chemical Industries, Ltd., Fellow in physics; Dr. F. M. Mohtadi, Imperial Chemical Industries, Ltd., Fellow in chemical engineering; R. T. Allsop and H. R. Thresh, research Fellows in industrial metallurgy; and Dr. M. A. A. Jorro, research Fellow in metallurgy.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: P. Devonald, agricultural officer, Northern Rhodesia; M. H. D. F. Fyfe, P. R. Goldsworthy and C. E. Metcalfe, agricultural officers, Nigeria; C. Harkness and G. Jenkins, plant breeders (botanists), Nigeria; A. J. Pritchard, geneticist, Tanganyika; J. A. Whitehead, agricultural officer, Tanganyika; J. H. Bean and D. E. H. Rishworth, geologists, Federation of Malaya; H. J. C. Kirk, geologist, North Borneo; J. B. E. Williams, geologist, Jamaica; K. S. Hedger, veterinary officer, Kenya; F. Manolson, veterinary officer, British Honduras; A. O. Merry, veterinary officer, Sarawak; E. D. Wright, veterinary officer, Nigeria; T. R. Barnard, assistant conservator of forests, North Borneo; J. P. Dempster, entomologist, Cyprus; C. J. Hadley, assistant conservator of forests, British Solomon Islands Protectorate; D. C. Lyon, assistant conservator of forests, Uganda; N. Manley, meteorologist, Trinidad; R. J. Murray, petrologist, Geological Survey, Gold Coast; G. M. Newble, meteorologist, Nigeria; H. E. J. Wools, assistant conservator of forests, British Guiana.

Announcements

THE David Anderson-Berry Prize for 1953 of the Royal Society of Edinburgh has been awarded to Dr. John Read, British Empire Cancer Campaign, New Zealand Branch, of the Medical School, Dunedin, New Zealand, for fundamental work on the relation between oxygen tension and the effect of X-rays on tissues.

DR. A. S. CLARKE, at present lecturer in zoology in the University of Glasgow, has been appointed assistant keeper in the Department of Natural History in the Royal Scottish Museum.

THE title of reader in entomology, as applied to hygiene, in the University of London has been conferred on Dr. J. R. Busvine, in respect of the post held by him at the London School of Hygiene and Tropical Medicine, and the title of reader in psychology in the University has been conferred on Dr. Hildegard T. Himmelweit, in respect of the post held by her at the London School of Economics and Political Science.

MR. ALEXANDER PATON, a divisional lands officer in the Department of Agriculture for Scotland, has been appointed technical development officer in the Department in succession to Mr. A. R. Wannop, now director of the new Hill Farming Research Organization. Mr. Paton is a former student of the University of Glasgow and of the West of Scotland Agricultural College and, after a short academic career, joined the Department of Agriculture for Scotland in 1931. In 1945 he became a divisional lands officer, first in the western area and later in the east, and recently he has acted as chief technical officer to the Hill Lands Commission. He is to be succeeded by Mr. J. S. Gibson, at present senior lands officer in the Department, with headquarters at Dundee.

THE new Chemistry Building of the University of Sheffield will be opened by the Earl of Scarbrough on February 5. A special degree congregation will be held on this occasion, when the following honorary degrees will be conferred: *LL.D.*, Mr. T. A. McKenna, chairman and managing director, Staveley Coal and Iron Co., Ltd.; *D.Sc.*, Sir Cyril Hinshelwood, professor of physical chemistry in the University of Oxford, and Prof. C. K. Ingold, professor of chemistry, University College, University of London.

IN order to assist laboratory workers who wish to protect rabbits against myxomatosis, the Laboratory Animals Bureau of the Medical Research Council has prepared a memorandum dealing with the aetiology, pathology and epidemiology of the disease, and with vaccination, together with some references. Copies of the memorandum can be obtained from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3.

THE Lalor Foundation, through a grant to the Marine Biological Laboratory, Woods Hole, Massachusetts, is offering a limited number of post-doctoral fellowships in the fields of biochemistry, biophysics and physiology, designed primarily for young scientists desiring to work not less than two consecutive months during the summer on investigations for which the opportunities provided by the Marine Biological Laboratory are particularly appropriate. The stipend is intended to cover laboratory fees, travel, and living expenses at Woods Hole. Completed applications should be received by January 31, 1954. Application forms and further information can be obtained from the Director, Marine Biological Laboratory, Woods Hole, Mass.

A FELLOWSHIP and a number of scholarships for work on arctic or sub-arctic research are being offered jointly by McGill University and the Arctic Institute of North America, with the financial support of the Carnegie Corporation of New York. The fellowship, which is worth 4,000 dollars, is for a senior worker who has completed his or her studies in the field and requires a year's residence at a centre of learning in order to prepare the results or to work on related topics. The scholarships are tenable at McGill University, normally for one year, and are worth 1,000 dollars with 1,250 dollars expenses for a summer field expedition. They are designed for taking a subject that requires active field research probably, but not necessarily, in order to proceed to a doctorate. Further information regarding these awards can be obtained from the Secretary, Carnegie Arctic Program, Arctic Institute of North America, 3485 University Street, Montreal, P.Q. Applications must be sent in by January 1, 1954, except that scholarship candidates not intending to do field-work in the summer of 1954 need not apply until April 1, 1954.

ERRATUM. In the article on "Advances in Methods of Studying Clays" (see *Nature*, 172, 287; 1953), the statement on p. 288, col. 1, lines 14–13 from the bottom should read: "In the second paper Dr. Gordon and G. W. Harris described . . .".

INSTITUTE OF PERSONNEL MANAGEMENT

THE annual conference of the Institute of Personnel Management is one in which eminent speakers are given opportunities to suggest means whereby the good human relationships already prevailing in British industry are maintained and extended. This pattern, and its bearing on productivity, was followed at Harrogate during October 4–6, when some eight hundred personnel officers from a large number of industrial undertakings in Britain and Commonwealth countries assembled at the fortieth anniversary conference of the Institute.

The introductory address was given by the Earl of Verulam, managing director of Enfield Cables, Ltd., who drew upon experiences derived from visiting some sixty foreign countries during the past few years to show that British industry will only be able to capture export markets when there is quicker practical application of new ideas and patents and a much more radical approach to topics like packaging and advertising.

In a paper sparkling with wit and profound simplicity, Prof. M. Kendall discussed the application of statistical method to human problems.

First, he suggested that a statistical attitude could be a useful corrective to errors of the intuitive approach even on delicate matters involving personnel selection and management; secondly, that statistical laws could often provide a yard-stick even if they were only honoured in the breach instead of in the observance; and, thirdly, that some businesses and some situations are so complicated that only a statistical control of staff is possible, short of overloading the concern with personnel management to an unbearable extent. Thus, in the case of labour turnover, it seems the general rule that turnover is more rapid for women than for men, that there are enormous variations in the rate from one business to another, and that the younger age-groups are more mobile than the older ones.

From the statistics he obtains, the statistician is able to discern definite patterns of behaviour which are observed in other kinds of industrial behaviour such as accident proneness; from the evidence, some individuals would seem to be as liable to change their jobs frequently as others are liable to accidents. This suggests that it might be possible to find some single measure of turnover which would eliminate the effect of individual proneness and reveal the essential differences between firms, so that a manager who was worried about his turnover figures could compare himself with the average or with comparable businesses, and begin to locate the source of the trouble or discover whether the remedial measures were likely to have the right effect in the right age-groups.

Statistical method could also be applied to one of the most outstanding problems of industrial management, the question of relative wages. The political conception that all men should be paid alike has largely disappeared, while the old economic forces which used to determine relative earnings under a *laisser-faire* economy have also been largely removed. In their turn, these controls have not been replaced by others to determine the basis upon which the earnings of different categories of workers might be based. Here the problem of relative earnings might be set in a statistical framework which shows that wage patterns follow the Pareto law, which was originally devised to govern the distribution of incomes. Despite the social revolution of the past fifty years, the law seems to have a kind of stability which is proof against even large changes in economic structure. In determining a fair wage structure, the Pareto law offers a standard by which to work and a yardstick by which to judge of the success and probable stability of the settlement.

Other fields where the statistician might have contributions to make to business organization are the optimum size of a business and the problem of centralization versus decentralization, the speed of diffusion of new ideas in different media which is important both inside and outside the business, the effect of medical advances on pension schemes and age of retirement; and there is a whole field of problems in business strategy, such as how to design an air service, which is generating a new subject known as linear programming. Prof. Kendall also described the application of statistical techniques to time studies and the selection of personnel.

A former adviser to the Government on important financial matters and now a director of several companies operating in the Far East, Sir Andrew McFadyean, examined the wider aspects of finance and full employment in a free society leading to a high and progressively higher standard of living. During the past few years a condition of full employment has been maintained whereby, according to a Nuffield College definition, the number of unfilled jobs has not been appreciably below the number of unemployed persons, so that any unemployment has been due to the normal lag between a person losing one job and finding another.

This period of full employment was the natural result of the release of civilian demand which was pent up during the years of war, the huge back-log of orders arising from the inevitable failure to maintain and renew plant and equipment, and of a policy which combined with a policy of cheap money a distaste for disinflationary measures. The rate of interest is all-important, since a very low rate of interest makes overdrafts easy; and, with prices rising, people are quite content, and even prefer, to put their reserves into stocks, rather than keep them in money; as soon as there is the slightest recession this begins to cause difficulty. When money becomes dearer, the difficulty may become acute. It also means, when there are more jobs than men, that employers pay quite a lot to keep their employees at almost any price. That is one of the tendencies which conflicts with what ought to be a feature of full employment, namely, much greater mobility of labour. Easy money also encourages spending, which is concentrated on consumer goods and conflicts with the desirability that people should save for capital purposes.

Full employment, as defined by Beveridge, depends, first, on a higher degree of discipline among workers, and on the capacity of management to meet new problems. Secondly, it depends on the formulation of some collective wage policy which would prevent one body of workers seeking a sectional advantage at the expense of all the others.

The difficulties of the post-war period of full employment have suggested that its maintenance

requires repeated periods of mild inflation to prevent prices from falling, to create an illusion of high profits, and to stimulate industrial producers to greater activity. But the open and avid pursuit of a policy of inflation to maintain full employment defeats its own ends. The possibility of saving will be diminished by constantly rising prices and the willingness to save will be weakened by the knowledge that money is likely to lose some of its purchasing power. This would lead to social instability of the gravest character. The maintenance of full employment depends on the ability to produce what the consumer wants at a price which he is able and willing to pay; it depends also on production at a profit. Machinery cannot be maintained, still less scrapped and replaced by new equipment, and the progress of invention and discovery cannot be maintained, unless a proportion of the profits earned are regularly set aside for these purposes. It is questionable whether the necessary provision for full employment is being made when a company pays well over half its profits to the Chancellor of the Exchequer by way of income tax and profits tax, and when the nominal profits on which it is taxed are, to an important extent, fortuitous because the amount which can be deducted from gross profits set off as depreciation takes no account of the real replacement cost.

The great mass of net income to-day is in the hands of people who have not been used to saving, largely because, in the past, they had no opportunity. It is to be hoped that thrift may be established among the rising generation of wage earners. There are, however, two dangers. A Welfare State does not encourage thrift, and unless full employment can be maintained without inflation and the rise in prices which inflation entails, it will be impossible to conceal that what is saved steadily decreases in value, and that, therefore, it would be better for people to consume more and save less. Full employment may actually be incompatible with that high standard of living which is to-day connoted by the term 'Welfare State'.

Nor must the industrialist produce at a profit what the consumer can and will buy; the consumer to be satisfied with a large part of the production is the foreign consumer. In selling abroad, British exporters are exposed to the fierce test of competition. In the ultimate analysis, workers, managers and investors are driven back to achieving not merely greater production but also greater productivity. Moreover, unless financial measures are taken to preserve the momentum of full employment, the country will, in due course, be faced with a percentage of unemployment which will represent many less jobs than seekers for work.

Sir Andrew stated that the maintenance of full employment, even in Britain, is a world problem and not a purely British one. It is primarily an American one. Unfortunately, if and when expenditure on arms is radically reduced, no American party, and therefore no American administration, dare aim at taking all the steps necessary to maintain a high level of industrial activity in the United States; it would involve a technique of control without detailed intervention.

To conclude the Conference, Sir John Woods, former Permanent Secretary to the Board of Trade and now a director of the English Electric Co., Ltd., discussed ways and means of convincing British people that the maintenance of existing standards of life depends upon their own efforts. Instead of the familiar slogan 'export or die', Sir John examined the role of imports in the British economy and suggested that the new slogan should be 'import or die'. Imports can now only be got from our own current labours. This, therefore, involves more production for export, and unless people were content with a good deal less for their own consumption, it means more total production. This larger total production has to be obtained at a time when means to buy the imports of materials for that production are lacking, and at a time when equipment—the actual capital equipment—is less than adequate because of what happened in the War.

Since the War there has been the greatest possible difficulty in obtaining imports. Throughout that period, import restrictions of one kind and another have been in force. Even that restricted volume of imports could not be obtained without assistance from overseas, and, for some time, credit from countries in the sterling area. In other words, the volume of our current foreign exchange earnings from exports has not been sufficient for the necessary, let alone the desired, volume of imports. Nor has there been at any time sufficient exchange reserves—particularly gold and dollar reserves—to tide us over for any period in which, for one reason or another (for example, a temporary falling-off in exports), our existing import bill could not be sustained out of current earnings. The gold and dollar reserves have been a barometer. There have been three crises since the War—in 1947, 1949 and 1951—and on each occasion the gold and dollar reserves drained away at an alarming rate.

The gold and dollar reserves are still not large enough to carry us over any period of recession which lasted for any length of time. In real purchasing power, the reserves are probably not worth more than a third to a half of what they were before the War, and the second cushion of the accumulated foreign investment does not now exist. If there should be an American recession of any length the prospects would be grave.

To-day there is some general awareness of the difficult and continuing national economic problem. Nevertheless, in spite of all that has been said and done on the subject of our national need for increased production and productivity, the basic truth has not been sufficiently absorbed. For example, it does not seem that the reports of the productivity teams have, in fact, been acted upon to any great extent. The argument has not gone deep enough into the community, and Sir John discussed reasons for this.

First of all, there is the essential difficulty of the subject. People really find it difficult to understand terms like inflation, deflation, exchange-rates, convertibility, tariffs and quotas, the terms of trade, and others. Moreover, these elements admit of different solutions.

Words like disequilibrium, balance of payments, the sterling balances, convertibility and GATT mean very little to the average person who is not forced to consider them as part of his occupation. Secondly, there has been too large an element of lecturing of the public—lecturing as opposed to discussion.

There is another class of difficulty which is more formidable. This is the fear of unemployment. The memories of 1931 are still very strong, and have

bitten very deep into the consciousness of people in Britain. These fears may not be wholly out of date. Britain is immensely dependent on world trading conditions, and if other countries will not, or cannot, buy our goods, or will not, or cannot, buy the primary commodities of the sterling area countries, recession and unemployment in Britain cannot be prevented. Our best chance of averting the worst consequences of a possible slump is to increase our present strength, and our reserves of strength, by following the doctrine of increased production and productivity.

The more intractable difficulty is the 'group' interest. In trade and industry, there are two clearly marked *large* groups—management or employers on one hand, workers or trade unionists on the other. Each of these groups itself comprises many other economic groupings. There are often disagreements and rivalries, stresses and strains, between the various component parts of, as well as between, the two groups. It is noticeable, for example, how strongly the pattern of wage claims is influenced by a desire in one industry to maintain its relative position *vis-à-vis* other industries, as though the existing pattern must be right for all time.

Within the field of economic groupings, each individual will tend to concentrate his attention on the particular section, probably the nearest and smallest to which he belongs, and much less attention on other sections, even those that belong to the same general group. If, too, within each group (that is, management–labour) there are rivalries and dissents, it is the more likely that when the opposing sides meet, at whatever level, it will be in an atmosphere of antagonism or 'againstness'.

As a result there is a danger of opposing for opposing's sake, and of missing the opportunity to construct new ideas to meet new needs. If this view of the group interest is correct, society as a whole, which is the biggest group of all, will get relatively little attention or understanding. Yet it is now the supreme individual interest of everyone to look at the problem of the society as a whole, for now we are concerned with survival as a nation, and failure would bring disastrous economic consequences to all.

How is that understanding and recognition to be brought about? One way might be in small discussion groups of people in the same factory or shop. If anything of this kind were to be tried, it would have to be carefully prepared, and the people who led these discussions would have to be people of very high calibre. It would also have to be done with the complete goodwill of the management and of the union concerned.

The other main feature of the annual conference of the British Institute of Management is a series of sectional meetings at which topics of particular concern to personnel officers are considered. This year four such meetings were held, and were arranged on experimental lines in order to secure maximum 'audience participation'. The matters discussed were the use of wages as an incentive to higher production, the means of securing co-operative attitudes from workers, personnel management as a career and the improvement of selection methods for unskilled workers. The experiments, which copied techniques borrowed from the United States, were sufficiently successful to merit further trials.

T. H. Hawkins

THE CRAFTSMAN IN THE ENGINEERING INDUSTRIES

A PRESIDENTIAL address delivered to one of the major professional institutions is normally devoted to the subject which has engaged the greater part of its author's career, and not unnaturally the study of man and men is therefore a frequent theme. In his presidential address on October 16 to the Institution of Mechanical Engineers, Mr. A. Roebuck turned his attention to the importance of the craftsman in industry, the necessity of the professional engineer recognizing his importance, and the necessity for the craftsman to be taught more of the scientific principles upon which his trade is based. With these sentiments no one can quarrel; but when Mr. Roebuck suggests that ". . . without the craftsman . . . the work of professional engineers and technicians would be of no avail, but, on the other hand, if the craftsman is left to himself he will produce an answer", an emphatic protest must be made. The double training of the professional engineer, so rightly insisted upon by the major institutions, makes it possible for him to learn rapidly any craft that he may need to master, while frequently enabling him to devise methods of manufacture which do not call for craftsmanship. The state of development of the mechanical engineering industry compared with that of the electrical industry should serve to underline the dangerous fallacy that is being propounded by Mr. Roebuck, since the former still depends primarily on the craftsman at the bench and the latter on the professionally trained designer.

It is fashionable to deplore the lack of skilled craftsmen and draughtsmen in engineering works to-day, and it seems a pity that Mr. Roebuck in his address did not analyse this very serious problem: it is primarily in the industries which are dependent on the professional engineer and the scientific worker that a major attack on the problem of training craftsmen thoroughly is being made, and that the best craft training schools now exist on a wide scale.

Some twenty years ago another president of the Institution of Mechanical Engineers, Sir Richard W. Allen, wrote a paper in which he directed attention to the very thorough training in craftsmanship given in the German-speaking engineering world, and suggested that it might profitably be introduced in Great Britain. In Britain a boy becomes a "craftsman" by serving a five-year apprenticeship; in Germany and Switzerland the boy has to pass a trade test at the age of eighteen in order to become a journeyman, and a further test at twenty-one in order to become a master. The examiners are skilled men appointed for the district, and the apprentice must produce detailed note-books showing sketches and descriptions, duly signed by his foreman, of every job that he has done. Many members of the teams that visited German industry at the end of the Second World War were struck by the pride taken by German works-managers and directors, more often than not graduate engineers themselves, in their training shops, which were to be found even in the smallest firms.

If, as Mr. Roebuck maintains and all will surely agree, the skilled craftsman in a works is all-important, why is he not treated as such and put on the staff? Admittedly the attitude of the trade unions has not been helpful when the idea has been raised; but every engineer must have been disturbed at some

time or another by the privileges enjoyed by junior office-workers in comparison with those accorded to tried servants of the company "on the clock".

An analogous position is to-day to be found in most drawing offices. At the top are skilled mechanical designers, mostly in their late fifties or sixties; but where are their successors? The men who should be following them started as apprentices in the shops, took the first opportunity to get out of the shops into the drawing office, and then proceeded by dint of hard work to qualify as associate members of one of the Institutions; this opened the door to 'design', sales and all the other apparently more lucrative and socially more attractive avenues in the company. Until the importance and the difficulty of first-class mechanical design-work on the drawing board is recognized in terms of both salary and status, the situation can only continue to decline, while professional engineers and scientific workers become ever more frustrated at the lack of men able to translate their basic concepts into hardware without constant supervision.

The old methods of training craftsmen both in the shops and drawing office depended essentially on time. During the War the Ministry of Labour training centres, making use of the work of Sir Frederic Bartlett, showed that by modern methods of selection and training a degree of skill could be attained by men and women in times that make nonsense of the old conception of the five-year apprenticeship. One looks forward to the day when it will be possible to review a presidential address describing the success of a large firm in applying scientific methods to the selection and training of its men.

D. B. WELBOURN

FORECASTING WEATHER FROM SOLAR RADIATION

MORE than seventy years ago Dr. S. P. Langley began measurements of the solar radiation and its spectrum. By 1902 his results had led him to the belief that the so-called 'solar constant' was in fact a variable, and that its variations might be an important factor in terrestrial weather. In 1905 the research was taken up by C. G. Abbot, who has continued it ever since with single-minded devotion. In the second of the two papers here under consideration*, he sums up his conclusions, in an endeavour to persuade meteorologists to abandon their general scepticism or lack of interest, and at least to give him a fair hearing.

There are several reasons for this scepticism. Measurements of the solar constant have to be made through the atmosphere, and even on high mountains a proportion of it fails to reach the ground. In theory it is possible to estimate the loss by making a series of observations at different solar elevations, but in practice the complex structure of the upper atmosphere makes the results somewhat uncertain, and many meteorologists remain unconvinced that the observed variations are not, in reality, variations of atmospheric absorption. Some even regard the average computed value of the solar constant as too low by an amount much larger than the observed variations. Agreement between values obtained in widely different parts of the world has done something to meet this objection, though it is probable that many of the disturbing factors, in the higher layers, are world-wide in extent. But even granted that the solar constant does vary, the variations found by Dr. Abbot are so small—only one or two per cent—that their direct effect on surface temperatures would be barely perceptible. Dr. Abbot counters this by the argument that the terrestrial effects are indirect, associated with changes in the location of the sub-tropical anti-cyclones and prevailing storm-tracks, and the frequency of hurricanes, all of which affect temperature and rainfall.

There is, of course, no doubt that changes do occur on the surface of the sun, and that some of them are more or less periodic—the existence of the sunspot cycle and of solar faculæ is sufficient evidence—and it is reasonable to accept that, along with variations of other types of radiation, such as corpuscular, ultra-violet and radio wave-lengths, they give rise to variations of visible and infra-red solar radiation. But Abbot goes far beyond this by claiming that these variations are strictly periodic, and that they are all harmonics of the double sunspot cycle of $22\frac{3}{4}$ years. He enumerates at least twenty-three such harmonics, ranging from $2\frac{1}{7}$ months to 272 months. The amplitudes obtained are mostly microscopic, of the order of 0·1 per cent.

Such a complex array would require a rigid mathematical basis to justify its acceptance; but the method by which it is arrived at is crude and can scarcely be described as mathematical at all. From the description, it consists of plotting the data on a long curve, regarding it from a distance, and picking out the dominant periodicity by eye. This is then computed arithmetically and eliminated, the process being repeated until only non-periodic variations are left. Anyone who has worked with periodicities will realize the pitfalls of this graphical analysis, for the eye of faith only too readily sees regularities in the most irregular of curves. The process is bolstered up by dividing the material into sections; but to the critical eye the agreement between the different sections is not very good.

When we turn to the effect of these supposed variations of the solar constant on weather, the impression received is equally dubious. Dr. Abbot himself writes: "*it would be quite impossible for meteorologists to discover these regular periodicities in weather elements had they not first been found in solar variation*". The italics are his; but it is difficult to see how this argument helps his case. In support, he produces a number of curves illustrating various solar periodicities in the temperature of Washington and the precipitation of Albany, for various seasons and intervals, for high and low sunspot numbers. Some of the series seem chaotic, but some do show an appreciable resemblance, which is enhanced by introducing rather arbitrary shifts of the time scale.

However, one must be fair. No matter how crude Dr. Abbot's methods may appear to a statistician, he has the courage of his convictions. In the first paper he gives a closer study to the monthly temperatures at Washington. In the departures of 1854–1939 from monthly averages, he finds no fewer than twenty periodicities ranging from $4\frac{1}{3}$ to $45\frac{1}{2}$ months. These were used as the basis for 'predicting' the departures for 1940–51, which were not used in the calculations

* Smithsonian Miscellaneous Collection: **122**, No. 1, Long-Range Effects of the Sun's Variation on the Temperature of Washington, D.C. (pp. 14; Pub. 4131); **122**, No. 4, Solar Radiation, a Leading Weather Element (pp. 35; Pub. 4135). Both by C. G. Abbot. (Washington, D.C.: Smithsonian Institution, 1953.)

of the periodicities. The results have a correlation of 0·504 with the observed values. From about thirty independent values (the figures are smoothed over five months) this makes a real connexion fairly probable (if it has not been introduced by the 'adjustments' of scale), but is far from justifying the claim that it is "obvious and certain". A further, real, forcast is given on the same basis for 1952–59, and it is interesting to compare the forecast temperatures with the observed as far as they are available (the observed temperatures have been supplied by the Meteorological Office, Harrow). Both forecast (*F*) and observed (*O*) temperatures are smoothed over five months.

		Jan.	Feb.	Mar.	April	May	June	
1952	*F*	39·1	40·4	47·3	56·9	66·2	72·6	°F.
	O	42·0	44·6	49·2	56·4	64·4	71·2	°F.
		July	Aug.	Sept.	Oct.	Nov.	Dec.	
	F	75·7	73·9	66·2	55·8	44·2	35·2	°F.
	O	73·6	72·0	66·2	57·8	50·6	45·2	°F.

		Jan.	Feb.	Mar.	April	May	June	July	
1953	*F*	35·3	35·9	43·1	54·2	63·7	72·4	78·9	°F
	O	43·6	45·2	51·4	58·2	65·8	71·4	74·2	°F.

Considering the extensive smoothing, while an error of less than 3° F. might be regarded as a good forecast, more than 3° F. would be poor, and more than 5° F. bad. The forecast temperatures are reasonably accurate for the first ten months of 1952 and for May and June 1953, but from November 1952 to March 1953 and July 1953 they fail badly. Twelve good against six bad forecasts suggest that, while there may be some basis for Dr. Abbot's predictions, it is far from sound, and certainly does not justify the issue of a forecast.

C. E. P. Brooks

FEDERAL FOREST ADMINISTRATION IN MALAYA

ANNUAL REPORT FOR 1951

THE annual forest reports of the Federation of Malaya for 1949 and 1950 gave testimony to the remarkable progress being made by the Forest Department in spite of the Japanese occupation during the Second World War and the present-day troubles (see *Nature*, 167, 679 (1951), and 169, 700 (1952)). The report for 1951* by the director of forestry, Mr. J. P. Edwards, shows that the progress has been continued.

Further to this, however, the report is of historical interest in that, in an introduction on the history of the Malayan forests and their development, material of vital importance is recorded which has so often been lost in other countries in the past through failure of records. As early as 1883 a small department was set up in the Straits Settlement under the director of gardens. Four years later Mr. H. N. Ridley became director, and he carried out an extensive programme of reservation of valuable forests which would otherwise have been entirely destroyed during the 1910 rubber boom in Malacca; reservation of forests on the higher hills in Penang was also effected. Control of the forests was assumed by the land officers in 1895 and continued until 1901. The forests of the former Federated Malay States had also been in charge of the district land officer in Perak, Selangor and Negri Sembilan.

The introduction of an up-to-date forest conservancy resulted from a visit of a distinguished Indian forest officer, Mr. H. C. Hill (later inspector-general of forests in India), in 1900, who submitted a comprehensive report on forest administration in the Colony. This was followed by the appointment in October 1901 of Mr. A. M. Burn-Murdoch (from the Burma Forest Department) as the first chief forest officer, Federated Malay States and Straits Settlements. Burn-Murdoch laid the foundations of the Department as it is to-day. The Department has been fortunate in having had several first-class successors to carry on the work so effectually. Forest research was started with the appointment in 1918 of the late Dr. F. W. Foxworthy as forest research officer. Not only did Foxworthy place the branch in a strong position which has since been added to (including recently a new up-to-date laboratory for research on wood anatomy, mensuration and timber); but his work also became widely known in other parts of the world.

E. P. Stebbing

* Report on Federal Forest Administration in the Federation of Malaya for the Year 1951. By J. P. Edwards. Pp. 67+4 plates. (Kuala Lumpur: Govt. Printer, 1952.) 2 Malay dollars or 4*s.* 8*d.*

TERTIARY FLORAS

THE rich fossil flora of the well-known Middle Tertiary lake bed at Florissant, Colorado, some 8,500 ft. up in the Central Rocky Mountain regions, is notable for its very numerous species and for the excellent preservation of the plant impressions of twigs and leaves, with some fruits, seeds and flowers: there is also an abundant fauna, chiefly of insects. The general features of the flora are well known from earlier descriptions by Lesquereux, Cockerell, Knowlton and others. A recent monograph by Dr. MacGinitie*, in the finely produced series of the Carnegie Institution of Washington, gives a revised and extended account of the flora, with a full analysis of its relationships with other floras of the remarkable North American Tertiary series, and special interest is attached to the use of the Florissant plant population as a climatic indicator, and in dating the lake bed, the age of which has been uncertain.

A glance at the list of synonyms and changes of name indicates the wide extent of the taxonomic revision involved. From earlier accounts, some 258 species have been described; but this revision reduces the number of well-established species to 114. Of these, 110 are species of seed plants (mostly trees and shrubs) representing 84 genera from 44 families, and 20 new species are included. The most abundant plant in the flora is *Fagopsis longifolia*, belonging to an extinct genus which so far as is known is peculiar to Florissant: this genus has previously been included in the Fagaceae, but is now referred by MacGinitie to the Betulaceæ on the evidence of the attached "cones". Among other abundantly represented species are *Zelkova drymeja*, *Chamaecyparis linguaefolia*, *Typha lesquereuxi*, *Populus crassa*, *Sequoia affinis*, *Cercocarpus myricaefolius* and *Athyana haydenii*. Using the fossil species the relationships of which with modern species are reasonably clear, a comparison is made with living floras: and the picture of the Florissant flora which emerges is one of predominantly warm temperate

* Carnegie Institution of Washington. Contributions to Paleontology. Fossil Plants of the Florissant Beds, Colorado. By Harry D. MacGinitie. Pp. iii+198+75 plates. (Publication No. 599.) (Washington, D.C.: Carnegie Institution of Washington, 1953.) Paper, 5.25 dollars; cloth, 5.75 dollars.

facies. The living species most similar to the majority of the fossil species are found in floras of the south-western interior of North America, principally in the Texas–Mexican region; but there are also plants at Florissant the present-day affinities of which are with Chinese, Californian and South American species. For example, the fossil species *Lomatia lineata*, which is identified from both foliage and fruit, is closely similar to the living South American *L. ferruginea*, and provides reliable evidence for a former more northerly spread of the Proteaceæ, which to-day is characteristically a family of the southern hemisphere. The comparison between the fossil species and these living representatives forms the basis of a reconstruction of the environment: the wide range and large number of species used gives conviction to the conclusion that the climate was probably a warm temperate one with a pronounced dry season, and this has had independent corroboration from a study of the fossil Diptera of the lake beds, as well as from the ecological indications of the associated sediments. The age of the lake beds is also deduced from the flora and is established as early Oligocene, after comparison with the Colorado Green River flora of mid-Eocene age and the Oregon Bridge Creek flora of Oligo–Miocene age, the two North American Tertiary floras of this region which show the most significant similarities with the Florissant flora. Again, there has been corroboration of this from a study of the scanty vertebrate remains and from the lithology of the deposits. While many of the species differences between these floras are no doubt due to extinction and to migration, it is clear that there are at least some species in the Florissant flora which are derivative from Green River forms, and the resemblances may, indeed, be due to continuous floristic development in the same area; for example, this may well have been the case with the species of the Asiatic genus *Zelkova* in the floras.

Though lacking any cuticular studies, which, indeed, may not be practicable with this material, such revision and analysis of a Tertiary flora bids fair to establish some of the history of the angiosperms, both of lineages and migrations, on a more secure basis, as well as offering useful indications of geological age and climate.

REGISTER OF RESEARCH IN THE SOCIAL SCIENCES

THE issue of the "Register of Research in the Social Sciences for 1952–3" (pp. 213; 1953; 25*s*.), published by the Cambridge University Press for the National Institute of Economic and Social Research, London, shows that the total amount of research of which particulars are given to the Institute is still increasing. This appears, however, to be due to the fact that the number of new entries each year greatly exceeds those which are removed from the "Register" because they are completed. During the preceding three years, the number of new entries has, in fact, fallen from 245 to 201, and although the number completed has risen from 121 to 140, the total number of entries has increased in the same period from 334 to 648.

This seems to show that research work in the social sciences tends to be a somewhat protracted process. It is obvious that most of the projects are being continued over longer periods than three years; but it remains to be seen how long it takes before the first substantial results are usually obtained from work of this kind.

Too much importance should not, however, be attached to these figures, or the conclusions based on them. The scope of the "Register" and of the projects listed in it is very wide indeed; the range is from "Soviet Law and Government" and "The Pure Science of Politics", which may be deemed to provide a lifetime of work for several scholars, to "What is an Office Manager?" and "A Forecast of Effects of Economies in London Telephone Directory Services", which are at least much more limited undertakings. The compilation of the "Register" is an exceedingly difficult task; but it will not be possible to use it for any more fundamental purpose than a mere list of work in progress unless the editors decide to prune the entries more rigorously.

DISTRIBUTION OF THE BRUSH POSSUM IN TASMANIA

By Dr. ERIC R. GUILER

Department of Zoology, University of Tasmania

THE brush possum *Trichosurus vulpecula* (Kerr) is found in most parts of Tasmania. In some localities, however, the distribution of the species is partly restricted by the absence of trees. One of the most interesting features of the biology of this species is the distribution of the black and grey colour phases. Pearson[1] found that there was no climatological reason for the apparently well-defined distribution of the black variety; but a recent examination of new material shows an ecological correlation of the distribution of the two colour phases.

The brush possum forms an important part of the Tasmanian fur industry, and skins collected during a short open season are liable to royalty. The royalties received are entered on a return by an officer, usually a policeman, acting on behalf of the Animals and Birds Protection Board. The statements are sent to police headquarters at Hobart. I am indebted to the Police Department for allowing me to peruse the returns, which show the number of water-rat, kangaroo, wallaby, ringtail and brush possum skins taken and the localities from which they came. The two colour phases of the animal are sufficiently important economically to warrant classification on the return as 'black possum' and 'grey possum'. Hence it is possible to obtain, assuming the form to be correctly entered, a reasonably accurate picture of the distribution of the two colour phases. Owing to the destruction of all records prior to 1947, those for the year 1949 are the only ones available. The years 1947, 1948 and 1950–51 were closed seasons. The total number of possum pelts taken is given in Table 1.

Owing to the lack of satisfactory evidence of place of capture, the figures, on which the distribution

Table 1

Number of *Trichosurus* pelts taken during the 1949 open season in Tasmania and the number included in the present survey:

	Black	Grey	Total
No. branded	22,792	68,023	90,815
No. included in present survey	11,988	23,250	35,238

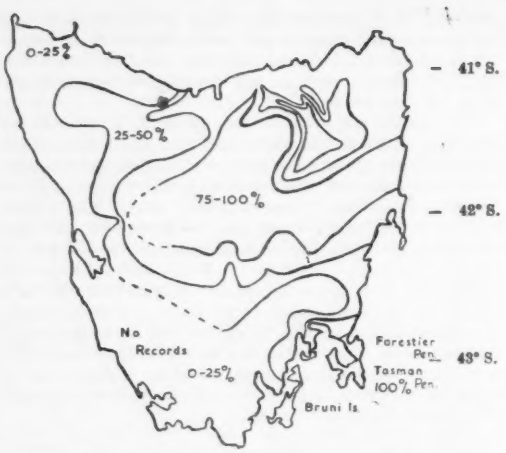


Fig. 1. Distribution of the black and grey colour phases of *Trichosurus* in Tasmania. The figures give percentage of greys

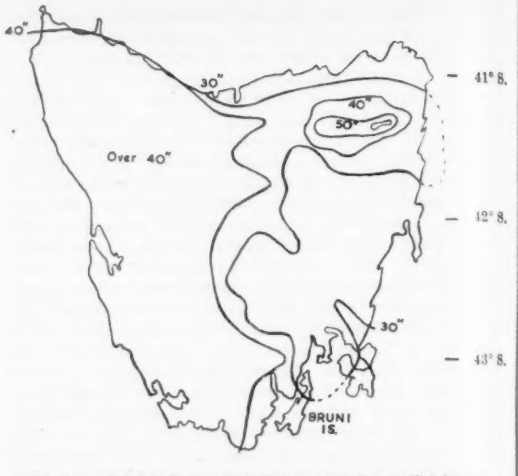


Fig. 2. Rainfall in Tasmania based on records supplied by the Hobart Weather Bureau

curves are based, do not include about two-thirds of the total number of skins taken. However, they do include just over 50 per cent of the black skins.

In the final analysis of the returns, the percentage of grey skins for 215 stations was obtained. These percentages were plotted on a map and the distribution curve drawn. Because in some cases the sample was not sufficiently large to be of significance, a few records had to be discarded.

In the present communication I employ the term 'possum' to distinguish the Australian phalangers from the American didelphids. In this I am following Troughton[2] and others.

Fig. 1 shows the distribution of the two colour phases of *Trichosurus* in Tasmania. The treatment used is the same as that employed by Pearson (*loc. cit.*), namely, the percentage of greys is shown. Individual stations are not indicated but will be listed in a later paper.

The most significant change from Pearson's map is the presence of an area of low percentage of greys in the north-east corner of the State. Whereas Pearson used figures from some eight stations in this area, I have utilized the results from fifty places, so giving a more detailed picture. The distribution can be seen immediately to be mainly correlated with rainfall (Fig. 2), although the presence of high land without any stands of large trees may modify the curve. In the regions of high rainfall, for example, the north-west, west coast and south-west of the State, there is a high percentage of black possums, whereas in areas of low rainfall there is a high percentage of greys. Thus the east coast and midlands are rich in the grey phase. The central highlands have a very high percentage of greys (98 per cent at Great Lake) and this region extends far out towards the west coast. The observations for this extension are very meagre, being based on a sample of fourteen from only one station, hence the curve is dotted. The 40-in. isohyet crosses the north coast in a position which is significantly close to that of the 25 per cent grey curve. Similarly, allowing for an inaccuracy resulting from the method of obtaining distribution results, the area showing a high percentage of blacks, in the north-east, also corresponds to the 40-in. isohyet.

There are no black possums on King or Flinders Islands in Bass Straits. This is in accordance with Pearson's findings, though there is a small percentage of blacks on Hunters Island, adjoining the north-west tip of Tasmania.

In the southern part of the island, the high percentage of blacks in the region extending almost across to the east coast does not correspond to the rainfall isohyet, nor to the distribution of forest areas. This distribution is based on percentages from only five stations, so there may be an experimental error, though the samples from four of these stations are each of more than twenty skins.

Pearson found a low percentage of black possums from the Forestier Peninsula as well as the Tasman Peninsula (83 per cent grey). Analysis of the 1949 figures shows that 22 per cent of the population on the Forestier Peninsula are black, but I have no figures from the Tasman Peninsula. From the known rainfall, the figure from the Forestier Peninsula is in accordance with expectations.

The only part of the Tasman Peninsula which experiences 40 in. of rainfall is a small area around Port Arthur, and in this area there is virtually no standing timber, heath being the dominant ecological feature. In a 40-in. rainfall belt black possums might be expected; but in this case local vegetational factors do not favour their occurrence. There is a similar 40-in. area near Adventure Bay on Bruni Island, but I have no observations from that region. In the Allonah area of Bruni Island there appears to be 100 per cent grey, which is again what one might expect. The following general correlation is shown in Table 2.

Table 2

Percentage of colour phase of *Trichosurus* correlated with rainfall

Rainfall	Percentage possum phase
> 40 in.	> 75 per cent black
30–40 in.	50–75 per cent black or grey
< 30 in.	50–100 per cent grey

The relative humidity on the east coast and the Midlands–Central Plateau region is lower than on the north-west coast, west coast and the south-west. The maximum humidity is 95 per cent near the west coast (Weather Bureau, 1936).

Pearson considered that an invasion of *Trichosurus* took place, the point of entry being from the north-east corner, and that the black form became more abundant the farther the species moved away from its point of entry. Huxley[3] follows Pearson's arguments. On superficial evidence this may be possible, but I consider it more likely that the black mutant arose in regions of Tasmania where the rainfall and humidity were found suitable, and that it has become dominant over such areas. This is more in accordance with the accepted general principle that in regions of high humidity the dark races are more frequent. Under such a hypothesis, the barrier effected by Eaglehawk Neck, which was described by both Pearson and Huxley as preventing the spread of the black form to Tasman Peninsula, does not need to be considered, because the low rainfall of the Peninsula would not be a suitable habitat for the black phase.

It is significant that not only does the distribution pattern of the black possum correlate with climatic and vegetational factors, but so, also, does the pattern in the black rabbit[4]. *Trichosurus* has been introduced into New Zealand; but it has not been established for a sufficient length of time for a rainfall distribution pattern to become apparent (Kean, personal communication). [July 29.

[1] Pearson, J., *Pap. Roy. Soc. Tasm.* 1937, 21 (1938).
[2] Troughton, E., "The Mammals of Australia" (Angus and Robertson, Sydney, 1941).
[3] Huxley, J. S., "Evolution—the Modern Synthesis" (London, 1942).
[4] Barber, H. N., "Distribution of the Black Rabbit in Tasmania" (in preparation).

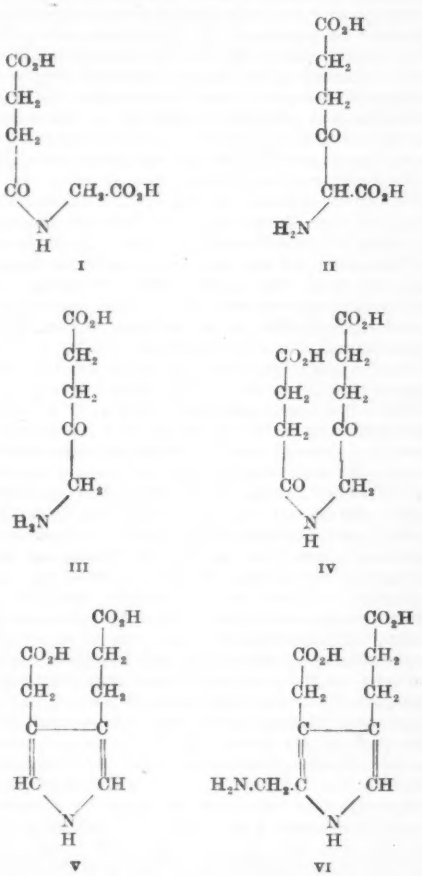
AMINOLÆVULINIC ACID AND PORPHYRIN BIOSYNTHESIS

By Dr. A. NEUBERGER, F.R.S., and J. J. SCOTT
National Institute for Medical Research, Mill Hill, London, N.W.7

It has been known for some time that the protoporphyrin molecule is synthesized in the red blood cell by condensation of eight molecules of glycine with eight molecules of a compound derivable from α-oxoglutarate[1,2]. Shemin and Kumin[3] showed by means of isotopically labelled acetate and succinate that such a compound appeared to be an asymmetric derivative of succinate. On the basis of the isotope data then available, a mechanism of porphyrin synthesis was suggested[4] in 1950 by which the first pyrrolic compound formed in the biosynthesis was a dicarboxylic pyrrole (V) with two free α-positions. It was then assumed that the methene carbon atoms (derivable from glycine) were added later; in this way the predominance in Nature of porphyrins related to aetioporphyrin III and the occurrence of smaller quantities of series I porphyrins could be explained.

With this theory in mind, we set out in 1952 to synthesize a number of compounds formally derivable from glycine condensed with one or two molecules of succinic acid, which might be intermediate in the conversion. We hoped that, by labelling the compounds isotopically, we would be able to demonstrate a higher degree of incorporation into hæmin than that obtainable with labelled free glycine or succinate.

A carboxyl group of succinic acid may be condensed with glycine either by N-succinylation or by an α-C-succinylation analogous to the Dakin–West reaction. In the first case succinamido-acetic acid (I), and in the second case α-amino-β-oxo adipic acid (II) would be formed. The latter compound would be expected to decarboxylate readily to form δ-aminolævulinic acid (III). By addition of a second molecule of succinic acid, succinamido-acetic acid or δ-aminolævulinic acid could be converted to δ-succinamidolævulinic acid (IV) by a similar process. This compound, by an oxidative self-condensation, might then form a pyrrole of the type shown below (V). A third possibility was that two molecules of δ-aminolævulinic acid could undergo a Knorr-type condensation to give a pyrrole, bearing in addition an aminomethyl α-substituent (VI).



In order to test these possibilities the following compounds were prepared. (1) [α-^{14}C] *succinamido-acetic acid* was prepared by condensation of ethyl [α-^{14}C] bromo-acetate with succinimide in the presence of potassium carbonate in dimethylformamide. This was followed by saponification with acid and hydrolysis of the imide by treatment with baryta. (2) *δ-Succinamido-lævulinic acid* was prepared by reaction of methyl succinyl chloride with diazomethane, and condensation of the resulting chloro-ketone with succinimide. Careful hydrolysis gave the required compound. (3) *δ-Aminolævulinic acid hydrochloride* was obtained from δ-succinamido-lævulinic acid or from methyl [^{15}N] δ-phthalimido-

lævulinate by acid hydrolysis. A third synthesis consisted of a condensation of phthalyl glycyl chloride with diethyl methyl ethanetricarboxylate, followed by ester exchange with benzyl alcohol and catalytic reductive de-esterification according to Bowman[5], and subsequent hydrolysis of the resulting δ-phthalimido-lævulinic acid. The latter method was designed as a basis for individual labelling of all five carbon atoms. The properties of δ-aminolævulinic acid hydrochloride were identical with those described by Corwin[6].

Experiments in rats and rabbits showed that [α-^{14}C] succinimidoacetic acid produced no significant labelling in the hæm of hæmoglobin isolated five days after intraperitoneal injection, nor was this compound converted to glycine at a significant rate. Tests kindly carried out by Dr. J. Lascelles, of the Department of Biochemistry, Oxford, showed that neither succinamido-acetic acid nor δ-succinamido-lævulinic acid stimulated porphyrin synthesis in intact cells of *Rhodopseudomonas spheroides*[7]; this could have been due to impermeability of the cell membrane. More conclusive negative evidence was obtained in tests of the two compounds by Dr. J. E. Falk and Dr. E. Dresel, of the Department of Chemical Pathology, University College Hospital Medical School, London, in a lysed fowl red cell system[8]. It seemed, therefore, that the first two possibilities, involving either succinamido-acetic or succinamido-lævulinic acid, had been excluded. On administration to rats of [^{15}N] δ-aminolævulinic acid hydrochloride, either by feeding or intraperitoneally, there was some labelling in the hæmin; but it was about five times lower than that resulting from an equivalent dose of [^{15}N] glycine. Experiments in which benzoate was injected at the same time showed that no extensive transformation of aminolævulinic acid to glycine takes place in the rat. However, tests in the lysed red cell system, kindly carried out by Dr. Falk and Dr. Dresel, showed that aminolævulinic acid is equivalent to porphobilinogen (see below) in producing a net increase in the levels of uro-, copro- and proto-porphyrin. These results suggest that the first pyrrolic compound formed is, in fact, compound VI. In May[9] and September[10] this year a structure for porphobilinogen was advanced, identical with VI. Evidence for the participation of porphobilinogen in porphyrin synthesis was obtained recently by Falk, Dresel and Rimington[11], who found that it was converted in 60 per cent yield to a mixture of porphyrins when incubated with lysed bird red cells.

Before the biological work with these labelled compounds was completed, a paper by Shemin and Russell[12] appeared, in which it was shown conclusively by the use of both [^{15}N]- and [δ-^{14}C]-labelled aminolævulinic acid that the incorporation of this compound into hæmin in a duck red cell system is forty-four times greater than that of similarly labelled glycine. The data presented here, particularly the observations of Falk and Dresel, confirm their findings.

Experiments to test the stability of δ-aminolævulinic acid hydrochloride in aqueous solution indicate that a condensation takes place, at a rate which increases with rise in *p*H, to form a compound which is not porphobilinogen, but which is believed to be a derivative of dihydropyrazine, by analogy with known reactions of α-amino ketones. It is presumably either for this reason, or owing to metabolic instability, that the utilization of aminolævulinic acid for porphyrin synthesis is so small when the compound is administered to the whole animal.

We wish to thank Dr. J. E. Falk, Dr. E. Dresel and Dr. J. Lascelles for their co-operation in the testing of these compounds, also Dr. N. Berlin, who assisted in the final stages of this work, a full account of which will appear in subsequent papers.

[Nov. 13.

[1] Wittenberg, J., and Shemin, D., *J. Biol. Chem.*, **185**, 103 (1950).
[2] Muir, H. M., and Neuberger, A., *Biochem. J.*, **47**, 97 (1950).
[3] Shemin, D., and Kumin, S., *J. Biol. Chem.*, **198**, 827 (1952).
[4] Neuberger, A., Muir, H. M., and Gray, C. H., *Nature*, **165**, 948 (1950).
[5] Bowman, R. E., *J. Chem. Soc.*, 325 (1950).
[6] Wynn, R. W., and Corwin, A. H., *J. Org. Chem.*, **15**, 203 (1950).
[7] Lascelles, June, *Biochem. J. Proc.*, **55**, iv (1953).
[8] Dresel, E. I. B., and Falk, J. E., *Biochem. J.* (in the press).
[9] Cookson, G. H., Rimington, C., and Kennard, O., *Nature*, 171, 875 (1953).
[10] Cookson, G. H., *Nature*, **172**, 457 (1953).
[11] Falk, J. E., Dresel, E. I. B., and Rimington, C., *Nature*, 172, 292 (1953).
[12] Shemin, D., and Russell, Charlotte S., *J. Amer. Chem. Soc.*, 75, 4873 (1953).

BIOLOGICAL SYSTEMS AND THE PRINCIPLE OF MINIMUM ENTROPY PRODUCTION*

By Dr. D. C. SPANNER

Department of Plant Physiology, Imperial College of Science and Technology, London

THE idea of a steady state is one which makes a fairly immediate appeal to our intuition, though it is not always clearly distinguished from the equilibrium state. In both, the observable characteristics of a system show no change with time; but while in the steady state there are one or more macroscopic processes continuously proceeding, any processes occurring in the equilibrium state are postulated rather than observed. The number of distinct observable processes accompanying the steady state is spoken of as its 'order', and with this convention equilibrium becomes merely the steady state of zero order. It is a well-known fact that a system left to itself reaches equilibrium when its entropy has increased to the highest possible value; and this consideration raises the question as to whether there is not some comparable 'variation principle' which could be established for the steady state. On the basis of the first and second laws of thermodynamics alone it proved impossible to find such a generalization; but an advance was made in 1931 when the Norwegian physicist Onsager introduced into thermodynamics the principle of microscopic reversibility, which simply states that if at a given instant the motions of all the particles of an isolated system could be exactly reversed, the system would retrace its former history.

Principle of Minimum Entropy Production

This led, in the hands of Prigogine[1] and others, to the realization that the characteristic property of a system which always tends to a minimum and which reaches it in the steady state is the entropy production; that is to say, the rate at which entropy is being created by irreversible processes within the system. If the system is quite unfettered it proceeds, of course, to equilibrium, when the entropy pro-

* The substance of an address delivered at the Sheffield meeting of the Society for Experimental Biology, 1953.

duction is actually zero; but steady states arise when in one or more ways the system is constrained away from equilibrium. In these circumstances it readjusts itself under the influence of the constraints to just such an extent as to reduce its entropy production to the smallest possible value. Thus, if a uniform solution in a rectangular vessel has opposite faces maintained at different temperatures, a partial separation of the constituents occurs (Soret effect). In accordance with the principle under discussion the concentration gradients which arise develop to the extent necessary to reduce the heat flow through the system to a minimum. If they are prevented from developing, say by thin partitions, the heat flow will remain at a higher value.

Of course, the fixed constraints applied to the system need not take the form of temperature differences. Gradients of concentration or chemical activity may be imposed, giving rise to transport processes as in the above example. Further, scalar 'forces' like chemical affinity may be involved, and these will produce continuous chemical reactions. Whatever the nature of the imposed 'forces', however, the system will readjust itself in any way open to it, and this readjustment will go only so far as suffices to reduce the total of the internal dissipative processes to their lowest possible value. How low this value will be it is impossible for thermodynamics to say. Sometimes the entropy production may fall scarcely at all; at others, it may become almost zero.

Biological Systems

Since biological systems are, broadly speaking, isothermal systems, it is more convenient in their case to speak of free energy rather than of entropy. Thus the steady state becomes a state of minimum dissipation of free energy. Put into this form, it appears that biological systems will show a tendency to conserve their free energy, a tendency already implied in ordinary physical laws. On the gross scale, as Prigogine and Wiame[2] have pointed out, this is rather clearly the case, for living organisms show a progressive decline during their lifetime in their rate of metabolism per unit mass. An obvious difficulty, however, lies in the fact that the curve of free energy dissipation does not fall consistently throughout the lifetime; even adult organisms show periodic outbursts of activity during which their energy dissipation must sharply increase. This, however, may be reconciled with the principle in at least two possible ways: sometimes the free energy dissipation may rise owing to a change in the external constraints, as when day succeeds night, or a meal is ingested; and sometimes a quiescent condition may be merely a *metastable* steady state. This latter may be the case when, without environmental stimulus, an animal becomes stirred to activity. In both cases the system may be supposed to move to a new steady state, determined in the first case by the new external constraints; and in the second, by the consideration that it is a more stable condition under the old constraints.

Structural Features of the Cell

Turning to the individual cell, it is possible to interpret some of its structural features as illustrations of the principle. Consider, for example, the perhaps universal occurrence of a fatty membrane of extreme delicacy around the cell, and probably around many of its internal structures as well. In an open system such as the cell, diffusion of metabolites inwards and outwards across its boundary will be a very essential part of its metabolic processes. Such diffusion, representing a dissipation of energy, is very materially hindered by the presence of the membrane, and it thus becomes possible to conceive of lipoid molecules arranging themselves in the most restrictive position much as a sponge does in an emptying bath. Similar considerations may, possibly, govern the structural localization of enzymes in the cell.

Biochemical Considerations

With regard to biochemical considerations it would seem that the principle has some very interesting implications. The enzyme phosphatase added to an aqueous solution of glucose phosphate will hydrolyse it to glucose and phosphoric acid, the standard free energy of the reaction being about 3,000 calories. If, however, a suitable alcohol be first added the phosphatase will catalyse the production of alkyl phosphate rather than phosphoric acid, in spite of the fact that the standard free energy change is considerably less, perhaps about 1,000 calories. Since the dissipation of free energy is the underlying principle regulating the direction of its vital processes, it is not at once apparent why the cell should choose a reaction dissipating a smaller amount of free energy when a reaction dissipating a larger amount is available to it. It would seem possible that this is an example of the minimum entropy principle, and that what actually happens in the above case is that after a short initial period of hydrolysis the system readjusts itself so that as far as possible the transphosphorylation of the alcohol is favoured at the expense of the production of acid. If this is so, then it can be seen that in a general way ordinary physical principles will lead to such an organization of the biochemical life of the cell that the pattern of change will be made up of small free energy steps, no doubt a most important factor in its energy economy. Such a pattern of organization has often been noted.

In this connexion one may see a new significance in the use, by the cell, of highly specific enzymes. By canalizing biochemical reactions into what are, in effect, narrow channels, the cell may create the possibility of the state of minimum dissipation being, in fact, a state of very low dissipation. This state of affairs is analogous to the use by the cell of a lipoid membrane of pronounced specific permeability to seal its boundaries.

Periodic Changes in the Environment

One interesting general consequence of the principle is revealed by the response of organisms to rapidly interrupted stimuli. Once a constraint has been applied, a system begins to adjust itself to the condition of minimum dissipation. This, however, requires time for its attainment. If the constraint or 'stimulus' is removed and reapplied at sufficiently short intervals it will have a greater effect per unit time of its application than if it acted steadily, since the system will never be allowed to reach its most conservative condition. Such a behaviour is shown, for example, in flashing-light experiments on photosynthesis, or in the enhanced rate of growth of roots rotated in a klinostat.

[1] Prigogine, I., Étude thermodynamique des processus irréversibles (Thesis). (Dunod, Paris and Desoer, Liège, 1947.)

[2] Prigogine, I., and Wiame, J. M., *Experientia*, **2**, 451 (1946).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Terminology of Enzyme Formation

It has been recognized for many years that in micro-organisms the formation of a large variety of enzymes can be specifically induced by exposing cells to compounds which are substrates for the enzymes in question. Recently, the same phenomenon has been demonstrated in a mammal[1], and it will probably prove to be a general property of biological systems. Since a change of this sort can occur against a constant genetic background, it must be distinguished from a change in enzymatic constitution that is primarily mutational. In order to distinguish between these two phenomena, microbiologists have for many years referred to the former type of enzymic variation as 'enzyme (or enzymatic) adaptation'. The term was, perhaps, an unfortunate choice[2,3] since the word 'adaptation' has an old and well-established biological meaning. In biological parlance, 'adaptation' denotes the modifications of either structure or function which increase fitness; mechanism is unspecified, and in fact both phenotypic and genotypic changes are included thereunder. Logically, therefore, 'enzymatic adaptation' should denote a modification of enzymatic constitution which increases fitness, irrespective of whether it involves genotypic or phenotypic change, and microbiologists have in fact often used it in this broader sense[4,5].

The use of the term 'enzymatic adaptation' to describe the direct induction of enzyme formation is open to objection for a second reason: enzyme formation can be specifically induced under conditions which preclude function of the enzyme so formed[3,6], a process which might be expected to have a negative effect (if any) on the fitness of the organism concerned.

It might prove unpractical to abandon the use of the term 'enzyme adaptation' altogether at this stage; but we should like to suggest that, in suitable cases where it is possible to be more precise as to the nature of the change underlying the increase in enzymic activity, a more accurate and significant terminology be employed. We therefore propose the following terms and designations; previously used terms are placed in parenthesis. A relative increase in the rate of synthesis of a specific apo-enzyme resulting from exposure to a chemical substance is an 'enzyme induction' (enzyme adaptation). Any substance thus inducing enzyme synthesis is an enzyme 'inducer'. An enzyme-forming system which can be so activated by an exogenous inducer is 'inducible', and the enzyme so formed is 'induced' (adaptive). Although many compounds can act both as inducer and substrate, the terms are not equivalent. Certain substrates for induced enzymes are not inducers, while some inducers cannot function as substrates of the enzymes the formation of which they elicit[3].

Many enzymes are formed in considerable amounts in the absence of an exogenous inducer. Such enzyme formation is 'constitutive' (constitutive). The amount of a constitutively formed enzyme can frequently be increased by specific induction, and it is also possible to obtain mutants in which synthesis of a particular enzyme is wholly constitutive (that is, not increased by any known inducer), from a parental type in which formation of the same enzyme is largely inducible[7,8]. Thus 'constitutivity' and 'inducibility' are properties of enzyme-forming systems, not of enzymes *per se*, and can be used as significant expressions only in a biological frame of reference, not in a chemical one. It should be stressed that the notions of constitutivity and inducibility are relative, not absolute; in any given biological system, a certain fraction of a particular enzyme-forming capacity may be constitutive, the remaining fraction inducible. For the sake of convenience, one may wish to refer to 'an induced enzyme' or to 'a constitutive enzyme'; but it should always be kept in mind that these are shorthand expressions for 'an enzyme the formation of which is largely or entirely inducible (or constitutive) in the particular organism concerned'.

The exposure of an organism to a single inducer which is also a substrate may result in the induction of a sequence of enzymes, since the metabolism of the primary, exogenous inducer gives rise to the formation of a succession of intermediary metabolites each of which in turn serves as an inducer for the enzyme which converts it into the next member of the metabolic chain. This phenomenon is termed 'sequential induction' (simultaneous or successive adaptation).

M. Cohn
J. Monod
Service de Physiologie microbienne,
Institut Pasteur, Paris.
M. R. Pollock
National Institute for Medical Research,
London.
S. Spiegelman
Department of Bacteriology,
University of Illinois, Urbana.
R. Y. Stanier
Department of Bacteriology,
University of California, Berkeley.
Oct. 8.

[1] Knox, W. E., *Brit. J. Exp. Path.*, **32**, 462 (1951).
[2] Stanier, R. Y., "Ann. Rev. Microbiol.", **5**, 35 (1951).
[3] Monod, J., and Cohn, M., *Adv. Enzymol.*, **13**, 67 (1952).
[4] Ryan, F. J., *J. Gen. Microb.*, **7**, 69 (1952).
[5] "Adaptation in Microorganisms", a symposium held by the Soc. for General Microbiology, London, 1953 (in the press).
[6] Bellamy, W. D., and Gunsalus, I. C., *J. Bact.*, **50**, 95 (1945).
[7] Lederberg, J., in "Genetics in the 20th Century" (Macmillan, New York, 1951).
[8] Cohen-Bazire, G., and Jolit, M., *Ann. Inst. Pasteur*, **84**, 60 (1953).

Nomenclature of *cyclo*Hexane Bonds

It was shown originally by X-ray and electron diffraction, and has been confirmed by other physical and by chemical means, that the most stable and permanent form of the *cyclo*hexane ring is that particular strainless form which is sometimes likened to a chair or a staircase. Geometrically, its chief feature is a six-fold alternating axis of symmetry. Its twelve extracyclic bonds fall into two classes[1]: six lie parallel to the axis, while six extend radially outward at angles of $\pm$ 109·5° to the axis. The stereochemical properties of substituents bound by these two classes of bond are so different that a need has been felt for verbal and symbolic means of distinguishing the classes.

The first suggestion[2] to this end designated the six parallel bonds as 'ε' and the others as 'χ'. However, although these symbols have been considerably used,

their origins in the Greek language, and particularly their allocation between two classes of bond, have been found difficult to remember. A more obvious description was given[3] when the six parallel bonds were called 'polar' and the others 'equatorial' by analogy with the geographical terms. This nomenclature has had a wide use, but is unsatisfactory in that it employs the word 'polar' for a stereochemical concept, thereby tending to confuse discussions which have to take account of the electropolar nature side by side with the stereochemical character of *cyclo*hexane substituents.

The purpose of this communication is to suggest a simple change which avoids these difficulties. It is that the six bonds parallel to the main *cyclo*hexane axis should be called 'axial'[4] (and symbolized '*a*'), while the other six retain the name 'equatorial' (and become symbolized '*e*'). (The term 'axial' was suggested to us by Prof. C. K. Ingold, University College, London.) The private discussions we have had with friends and colleagues lead us to hope that this suggestion may find favour.

D. H. R. Barton
Birkbeck College, University of London.

O. Hassel
University, Oslo.

K. S. Pitzer
University of California, Berkeley.

V. Prelog
Federal Technical Highschool, Zurich.

[1] Kohlrausch, K. W. F., Reitz, A. W., and Stockmair, W., *Z. phys. Chem.*, B, **32**, 229 (1936).
[2] Hassel, O., *Tidsskr. Kjemi, Bergv. Met.*, **3**, 32 (1943).
[3] Beckett, C. W., Pitzer, K. S., and Spitzer, R., *J. Amer. Chem. Soc.*, **69**, 2488 (1947).

Determination of Dry Mass, Thickness, Solid and Water Concentration in Living Cells

In previous communications it has been shown that the measurement of phase change by interference microscopy can be used for determining the dry mass of living cells[1], and the measurement of refractive index enables the concentration of solids and water to be calculated[2]. The combination of these techniques gives a method of measuring the thickness and hence the volume of living cells.

The principle of the method is to measure by interference microscopy the phase changes produced by an object when immersed successively in two media of different refractive indices. Let μ be the refractive index of the object, and t its thickness.

Let φ_1, φ_2 be the phase changes measured when the object is immersed in media of refractive index μ_1, μ_2, respectively. Then

$$\varphi_1 = (\mu - \mu_1)\, t\,; \qquad \varphi_2 = (\mu - \mu_2)\, t.$$

$$\text{Hence } \mu = \frac{\mu_2\varphi_1 - \mu_1\varphi_2}{\varphi_1 - \varphi_2} \quad \text{and} \quad t = \frac{\varphi_1 - \varphi_2}{\mu_2 - \mu_1}.$$

These two measurements thus suffice to determine both the refractive index and the thickness of a homogeneous object.

In the case of living cells, we can write[1,2]:

$$\mu = \mu_s + \alpha C,$$

where μ_s is the refractive index of the intracellular fluid (effectively a dilute salt solution with a refractive index very close to that of water), α is the mean refractive increment of the cell solids, which can be taken as 0·0018, and C is the concentration of cell solids expressed as grams per 100 ml. If the cell is immersed in two different concentrations, C_1, C_2, of a suitable protein medium[2], we can write $\mu_1 = \mu_s + \alpha C_1$ and $\mu_2 = \mu_s + \alpha C_2$.

$$\text{Hence we obtain } C = \frac{C_2\varphi_1 - C_1\varphi_2}{\varphi_1 - \varphi_2} \text{ and } t = \frac{\varphi_1 - \varphi_2}{\alpha(C_2 - C_1)}.$$

In practice, the method is greatly simplified by carrying out the first measurement of phase change (φ_1) in a saline medium. In this case $C_1 = 0$, so that:

$$C = \frac{C_2\varphi_1}{\varphi - \varphi_2} \quad \text{and} \quad t = \frac{\varphi_1 - \varphi_2}{\alpha C_2} = \frac{\varphi_1}{\alpha C}.$$

The experimental procedure is thus to measure the phase change first with the cell mounted in a saline medium, then to run in a dilute protein solution under the coverslip and take the new measurement. Not only does this method give more information than either straightforward interference microscopy or refractometry alone, but also it has the important advantages of not requiring an accurate refractive match and of allowing the use of much less concentrated protein solutions than is needed in ordinary refractometry.

Typical results obtained for different regions of the cytoplasm of human oral epithelial cells are given in Table 1. Values for dry mass per unit area in grams per square micron, thickness in microns, and concentration of solids in grams per 100 ml. have been calculated. The concentration of water as a percentage of total wet weight is given with sufficient accuracy by $100 - C$. Monochromatic green mercury light (λ 546 mμ) was used for the measurements.

Table 1

C_2 (per cent)	$\varphi_1°$	$\varphi_2°$	Dry mass (gm./μ^2)	C (per cent)	Concentration of water (per cent)	Thickness (μ)
8	17·3	7·1	$1{\cdot}44\times10^{-12}$	13·4	86·6	1·07
12	32	10·5	$2{\cdot}67\times10^{-12}$	17·4	82·6	1·50
6	4·5	3·0	$0{\cdot}38\times10^{-12}$	18·0	82·0	0·21
6	11·0	6·5	$0{\cdot}92\times10^{-12}$	14·7	85·3	0·64

It will be seen that there is a considerable range of variation of thickness in these cells, though they are all very flat. On the other hand, the concentration of solids lies within the range previously reported[2] and is much more constant. Refractive index and solid concentration are much more fundamental quantities than the phase change or dry mass, which depend on local variations in thickness in different parts of the same cell. A knowledge of the distribution of dry mass by itself is therefore of very limited value. The determination of solid concentration either as described here or previously[2] is virtually essential. In homogeneous regions of the cell the volume can be found by integrating the product of the projected surface area and thickness. As will be discussed elsewhere, however, serious errors may arise in the case of very heterogeneous regions, and only approximate calculations can be made in such cases.

I wish to acknowledge the help received as Johnston, Lawrence and Moseley Research Fellow of the Royal Society. This work was carried out with

interference microscopes kindly lent by Messrs. Charles Baker and Mr. J. Dyson.

R. Barer

Department of Human Anatomy,
University Museum,
Oxford. Oct. 28.

[1] Barer, R., *Nature*, **169**, 366 (1952).
[2] Barer, R., and Ross, K. F. A., *J. Physiol.*, **118**, 38*P* (1952). Barer, R. Ross, K. F. A., and Tkaczyk, S., *Nature*, **171**, 720 (1953).

Origin of the Pituitary Body of Chordates

My earlier investigations on the neural gland of tunicates may perhaps throw some light on the origin of the pituitary body in vertebrates. I have adduced evidence[1-4] that the neural gland (plus ciliated pit) of tunicates is the homologue of the vertebrate pituitary body. The mouth of the ciliated pit, then, is the homologue of the opening of Rathke's pouch, and as such does not enter into the structure of the pituitary proper. The stage in the development of the tetrapod pituitary at which Rathke's pouch is open is thus a 'recapitulation' of a phylogenetic step, still extant in ascidians.

Now what is known of the function of the pituitary in ascidians? I have shown that it is a chemoreceptor for detecting the presence of gametes of its own species in ingested water[3]; and it is probable that it may also act as a sense organ (in *Salpa* at least) for assaying the relative abundance of particles (food particles) in the ingested water[5]. Can it be that the pituitary is primitively a sense organ? This is the hypothesis which best fits the data. The only proved function of the pituitary in ascidians is that of chemoreception, and the ascidians are more primitive than any other chordate whose pituitary has been investigated; moreover, no other chemoreceptor is known in ascidians. The pituitary seems, in fact, to be the organ of olfaction in these forms. It has often been postulated that the pituitary shares with the nose proper an olfactory function in the cyclostomes; and Prof. R. Dohrn informs me that recently workers in his laboratory have shown this to be so in *Torpedo*. It has been replaced, however, by the 'nose' for this function in the higher chordates. Why has such a replacement taken place?

It seems most likely that the change from a benthic to a nektonic way of life has necessitated the development of a faster-acting olfactory organ than the pituitary body, in which the passage of information to the brain is chemical[3]. The new, fast-acting olfactory organ, of course, passes its information by nerves. It may be, indeed, that the new olfactory organ develops by innervation of part of the pituitary: the association of pituitary and nervous olfactory organ in the cyclostomes may perhaps suggest this. However this is, the pituitary proper, having lost its olfactory function, now presumably remains because its incretory products, once just of use for conveying information to the brain, have meanwhile become important for other purposes. For example, the gonadotropins of the pituitary, which in ascidians convey information of the presence of gametes to the brain, have in the vertebrates become essential to the gonads for their development: the site of action of the hormone has changed from the brain to the gonad. The reflex chain of the ascidians, deduced from the experiments described in an earlier paper[3], has been short-circuited to some extent, cutting out the neural arm of the reflex arc, so that both arms are now hormonal. The organ, the original function of which has become obsolete in higher chordates, remains because its incretory products have become essential to the body. This seems to be yet one more example of the rule that endocrine organs originally possessed some other function. Thus the thyroid is first a feeding organ, the endostyle, and when this method of feeding becomes obsolete in the evolutionary ascent the endostyle has to remain as a purely endocrine organ, since an incretory product has become essential to the body; the pineal is first an eye; the gonads are reproductive organs before they are endocrine glands; the first function of the pancreas seems to be to secrete digestive enzymes. In every one of these endocrine glands, including the pituitary body, the endocrine function seems to be secondary. The first function of the pituitary would appear to be one of chemoreception.

David B. Carlisle

Marine Biological Laboratory,
Plymouth. Sept. 1.

[1] Carlisle, D. B., *Pubbl. Staz. Zool. Napoli*, **22**, 192 (1950).
[2] Carlisle, D. B., *Nature*, **166**, 737 (1950).
[3] Carlisle, D. B., *J. Exp. Biol.*, **28**, 463 (1951).
[4] Carlisle, D. B., *Quart. J. Micr. Sci.*, **92**, 201 (1951).
[5] Carlisle, D. B., *Pubbl. Staz. Zool. Napoli*, **22**, 146 (1950).

Premature Oviposition in the Hen

It has been reported recently[1] that after various operations on the albumen-secreting region of the hen's oviduct, oviposition ceased almost entirely. This failure to lay was taken as evidence of a failure to ovulate and was attributed to inhibition at the pituitary and by direct nervous stimulation from the oviduct.

During similar experiments, reported in this communication, it was noticed that if a loop of suture silk was placed in the shell gland in the manner described by Huston and Nalbandov[1], the production of normal hard-shelled eggs was replaced by the production of soft-shelled eggs in more than half the birds operated upon. In these birds ovulation continued at nearly the same rate as before the operation; but the yolk could not be retained in the oviduct long enough for egg formation to be completed. About half the resulting soft-shelled eggs had membranes and the rest were of yolk and albumen only.

Table 1 shows the number of normal and abnormal eggs produced by eight of the fourteen experimental birds for up to forty days after the operation; the remaining six birds and six controls continued laying normally at an average level of 70 per cent.

Table 1

Hen No.	Control period 10 days		Days after the operation 1–10		11–20		21–30		31–40	
	H	*S*	*H*	*S*	*H*	*S*	*H*	*S*	*H*	*S*
A	7	0	0	6	0	6	0	6	0	3
B	5	0	0	0	0	5	0	6	0	7
C	7	0	1	2	0	4	1	5	–	–
D	7	0	2	3	0	3	0	4	0	2
E	4	0	1	4	0	4	0	6	0	4
F	6	0	1	5	0	7	0	5	0	2
G	5	0	0	2	0	6	0	5	0	5
H	9	0	4	3	2	5	0	7	0	5

H = No. of hard-shelled eggs; *S* = No. of soft-shelled eggs.

These experiments are continuing and will be reported in detail later.

A. H. Sykes

Poultry Research Centre, Edinburgh 9.

[1] Huston, T. M., and Nalbandov, A. V., *Endocrin.*, **52**, 149 (1953).

Thermal Contraction of Collagen and its Dissolution with Elastase

The structure and chemical characterization of elastic tissue by means of elastolysis and electron microscopy have been studied by Hall, Reed and Tunbridge[1], and by Lansing, Rosenthal, Alex and Dempsey[2]. The results of both laboratories agree in showing the complex nature of collagen-free elastin originating either from aorta or ligamentum nuchæ. In the elastic tissue the existence of a cement material —matrix—is suggested, of which the physical and chemical properties are similar to the fibrils imbedded in it. Recently, Schwarz and Dettmer[3], working with fresh aorta imbedded in cremolan (*Dünnstschnitte*), found that during dissolution of elastin fibres by elastase, only the matrix called *Kittsubstanz* is dissolved, while fibrillæ remain intact and can be examined in the electron microscope. The elementary fibrillæ of the elastic fibres are identical with the collagen fibrils and also are periodically cross-striated. The discrepancy between the results of Hall *et al.*[1] and of Lansing *et al.*[2], on one hand, and of Schwarz and Dettmer[3], on the other, could be explained by my observation[4] that if fibres of collagen or purified collagen tissues are contracted by heat they can be dissolved by elastase. In order to obtain purified elastin the tissue must be boiled; the same procedure was employed by Stein and Miller, who boiled the ligamentum nuchæ in water for many days to remove collagen. Lansing *et al.*[2] described the preparation of pure elastin by boiling the tissues with 0·1 *N* sodium hydroxide for 45 min. at 98°. In their experiments, the amorphous matrix as well as the fibrillæ imbedded in it were dissolved during elastolysis, whereas in the experiments of Schwarz and Dettmer[3]—without heat denaturation—elastase produced only the dissolution of the *Kittsubstanz*.

The collagen can be dissolved by elastase if it is kept in water of 70° for 5–10 min., or in 2 per cent acetic acid at 60° for 5 min. Partridge[5] has shown that from dried cartilage powder after a short heat treatment with water at 60–70° a soluble mucoid may be extracted. The temperature required to liberate mucoid is reduced in the presence of calcium chloride, alkalis and formamide, and the conditions necessary to secure extraction in good yield are generally those which give rise to thermal contraction of collagen. Using Achilles tendon of cattle in my experiments, I succeeded in showing that during thermal contraction in water 5–6 per cent of the dry weight of collagen can be extracted. The extracted substance contains 6–8 per cent of polysaccharide, determined by Rimington's method[6], which is 25–30 per cent of the polysaccharide contents of the collagen. The transformation of collagen to an elastolytically soluble substance at lower temperature does not take place with 10 per cent calcium chloride or formamide; but it occurs in presence of 2 per cent phosphotungstic acid. Heat-denaturated collagen fibre, as well as phenol-treated collagen fibre, is rubber-like, showing elastic properties.

After thermal contraction, collagen loses its swelling capacity and is solubilized by elastase ten times faster than elastin itself. The substance of elastolytically dissolved collagen—called collagenolysate—is in respect of protein precipitation and dialysis similar to elastolysate derived from elastin. During dissolution the dicarboxylic amino-acids—aspartic and glutamic acids—of the collagen molecule are liberated in all probability from their amide bonds; thus in the collagenolysate using Willstätter's method, 1·1–1·2 mol. COOH/gm. collagen is found.

Both collagenolysate and elastolysate show a strong reducing action for which their polysaccharide content (1·2–1·8 per cent) cannot be responsible. This reducing capacity is revealed in the consumption of bromine or iodine, in showing positive reaction with Schiff's reagent after precipitation with 5 per cent phosphotungstic acid, and also in giving—without alkali treatment—red coloration with the Ehrlich reagent (*p*-dimethyl-amino-benzaldehyde) characteristic of pyrrole derivatives. These reactions misled us in our previous work[7], suggesting the presence of a greater quantity of carbohydrate (10–12 per cent) resembling glucosamine in the elastolysate.

In respect of amino-acid content, collagen differs from elastin in that it contains four to five times more dicarboxylic amino-acids. Probably the collagen fibrils are surrounded with the mucopolysaccharide-like envelope bound by the dicarboxylic acids; this prevents the elastase from attacking the appropriate group of molecules and exercising its digesting effect. If the mucopolysaccharide is removed by heat denaturation, the elastase dissolves collagen, which means that in collagen as well as in elastin the same structural elements are present upon which elastase acts specifically. In studying the elastolysis of heat-denaturated collagen obtained from rat's tail by means of the polarization microscope, it was shown that in agreement with Partridge's[5] results the contraction of collagen fibre is followed by its relaxation, depending on the heat and the salt concentration of the medium. Elastolysis ensues only in cases in which the fibres are already relaxed, and the first effect of elastase is to segregate the collagen fibre into fibrils parallel to its long axis like a broom. Then the fibres gradually lose their double refraction and fall to pieces. All these experiments seem to support my former view that the mechanism of elastase action consists of depolymerization of the protein molecule and transformation of the rod-shaped molecules into globular proteins. Experiments (unpublished) show that following the depolymerization process induced by elastase, a component arises which gives a mean molecular weight of 10,000–20,000. After inactivation of the enzyme, the breaking down continues and gives rise to products of a mean molecular weight of about 2,000.

A paper containing the detailed results of the experiments will be published in the *Acta Phys. Hung.*

I. Banga

First Department of Pathological Anatomy
and Experimental Cancer Research,
University of Budapest.

Oct. 9.

[1] Hall, D. A., Reed, R., and Tunbridge, R. E., *Nature*, **170**, 264 (1952).
[2] Lansing, A. I., Rosenthal, T. B., Alex, M., and Dempsey, E. U., *Anat. Rec.*, **114**, 555 (1952).
[3] Schwarz, W., and Dettmer, N., *Virchows Arch.*, **323**, 243 (1953).
[4] Banga, I., meeting of Hung. Phys. Assoc., 1953.
[5] Partridge, S. M., *Biochem. J.*, **43**, 387 (1948).
[6] Rimington, C., *Biochem. J.*, **34**, 931 (1940).
[7] Banga, I., and Baló, J., *Nature*, **171**, 44 (1953).

The observation of Dr. Banga that thermally contracted tendon collagen is dissolved under the action of elastase is obviously of great importance. There is considerable evidence that elastin preparations from aorta and from ox ligament, even after the presumed removal of collagen, do not present single substrates to the action of elastase[1]. In the course of a search for a purer substrate for elastase, we have also observed the dissolution of thermally contracted collagen both from Achilles tendon and from rat tail tendon. In addition we have found that elastase, acting at *p*H 8·7, causes the dissolution of the water-insoluble protein in bovine crystalline lens and of the lens capsule. The dissolution of lens capsule is particularly interesting, since the material shows some similarity in amino-acid composition to collagen, its X-ray diffraction pattern is like that of a partially oriented collagen, it contains much polysaccharide and has a definite marked shrinkage temperature between 60° and 70° [2]. We have thus shown that elastase will attack a collagenous material even when it has not been thermally contracted.

The complex structure of aorta and the close association of collagen and elastin fibres in this material makes it difficult for us to accept Dr. Banga's interpretation of the work of Schwarz and Dettmer[3]. With reference to their observations that the elastin fibrils are not dissolved under the action of elastase and are similar to collagen fibres in certain respects, we would point out that the particular set of conditions they employ, namely, incubation for ten hours at 37°, and *p*H 7, are not optimum for the action of elastase[4], and, moreover, they do not seem to have taken any special steps to remove collagen. The possibility pointed out by Dr. Banga, however, that the fibrillar structure of elastin may be altered in some way during the heat treatment employed for the removal of associated proteins is of fundamental importance, and one which must be constantly borne in mind.

D. A. Hall
R. E. Tunbridge
G. C. Wood

Department of Medicine,
University of Leeds.

[1] Hall, D. A., Abstr. 2nd Cong. Biochem., p. 272 (1952).
[2] Pirie, A., *J. Biochem.*, **48**, 368 (1951).
[3] Schwarz, W., and Dettmer, N., *Virchows Arch.*, **323**, 243 (1953).
[4] Hall, D. A., Reed, R., and Tunbridge, R. E., *Nature*, **170**, 264 (1952).

'Multiple Dipping' Procedures in Paper Chromatography: a Specific Test for Hydroxy-proline

Much industry has been devoted in recent years to methods for locating the position of components separated on paper chromatograms, and claims have been made for many reagents of greater or less specificity. We wish to report our experiences in locating compounds on paper chromatograms by the successive application of several reagents with different specificities.

We have used mainly the better-known amino-acid and amine reagents, and find that several of them can be used one over the other if applied in an appropriate order. The use of Pauly reagent to confirm the identity of histidine after location with ninhydrin was advocated by Dent[1], and the use of two superimposed reagents, usually with the second applied to selected areas of the chromatogram only, has been mentioned by others[2]. Application to selected areas only is to be avoided if possible, since this is likely to miss the presence of other interesting reactors, as well as ending with a blotched chromatogram. We have used only the 'dipping' technique[3] for application of the reagents used; and we obtain a very uniform background even after four reagents have been superimposed.

Ninhydrin, isatin and Ehrlich reagents are prepared and used in the manner already reported[3]. Our dip reagent for the Sakaguchi reaction is a 0·1 per cent solution of 8-hydroxy-quinoline (oxine)[4] in acetone; after drying in air, the paper is then dipped into a solution of 0·2 ml. bromine in 100 ml. *N*/2 sodium hydroxide; arginine and other guanidines give brilliant orange-red areas, fading slowly. The modified diazo reagent formed from amyl nitrite and *p*-anisidine in ethanol[5] gives excellent results as a dip reagent for histidine and other iminazoles, but poor results with tyrosine. The nitroso-β-naphthol/nitric acid reagent of Acher[2c], specific for tyrosine and certain of its derivatives, can be applied as acetone solutions.

After applying one reagent, the chromatogram is heated or left for full colour development to proceed. Spots and colours are then marked with lead pencil, the next reagent applied to the whole chromatogram, and so on. We term this a 'multiple dipping' procedure.

Maximum information is given by sequences such as: ninhydrin or isatin, followed by Ehrlich reagent, followed by Sakaguchi reagent or diazo reagent. Ninhydrin can be applied over isatin. With the notable exception of hydroxy-proline (see below), the colours given by amino-acids with ninhydrin and/or isatin are rapidly 'rubbed out' by the strongly acidic Ehrlich reagent, which must therefore be applied after these two. It can, however, be followed by Sakaguchi reagent, or by the diazo reagent if 2*N* sodium hydroxide is used as dip solution for the coupling reaction. The nitroso-β-naphthol reagent is applicable after ninhydrin or isatin, but its sensitivity is considerably diminished. Other sequences of these reagents are incompatible or of little value.

This multiple dipping technique is useful for confirming, by specific reagents, the nature and position of components first located by a general reagent; for revealing the composite nature of a single spot; and for revealing two or more sets of components which do not each respond to the same general reagent (for example, urinary indolic compounds in the presence of amino-acids). A single one-way chromatogram treated with four separate and specific reagents can often give more information than a two-way chromatogram, with consequent saving of time and labour. We are at present utilizing the technique in the photometric scanning of chromatographic strips, the application of the various reagents yielding records which are directly comparable.

In general, the usual colour responses and sensitivities of amino-acids to the reagents mentioned are almost unaltered by previous treatment. One important exception constitutes a highly sensitive and specific test for *hydroxy-proline*. After heating with isatin, the duck-egg blue colour due to hydroxy-proline is replaced by an intense purplish-red (cerise) colour within a few seconds of applying Ehrlich reagent over it. The effect is not seen when either acid or dimethylamino-benzaldehyde is applied alone. This colour test will detect hydroxy-proline at a concentration on paper chromatograms of 0·1 μgm./sq. cm.—considerably beyond the sensitivity

of the simple isatin or ninhydrin reactions. It is entirely specific for hydroxy-proline among more than a hundred and twenty amino-acids, amines and heterocyclic acids tested.

We suggest that when new location reagents are examined, the extent to which they may be used in the ways outlined here should be investigated.

JOHN B. JEPSON
IVOR SMITH

Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.
Oct. 27.

[1] Dent, *Biochem. J.*, **43**, 169 (1948).
[2] For example, (*a*) Toennies and Kolb, *Anal. Chem.*, **23**, 823 (1951). (*b*) Hausmann, *J. Amer. Chem. Soc.*, **74**, 3181 (1952). (*c*) Acher and Crocker, *Biochim. Biophys. Acta*, **9**, 704 (1952).
[3] Smith, *Nature*, **171**, 43 (1953).
[4] Sakaguchi, *J. Biochem. (Japan)*, **37**, 231 (1950).
[5] Sanger and Tuppy, *Biochem. J.*, **49**, 463 (1951).

Effect of Surface Films on the Evaporation of Water

By a variety of laboratory experiments, it has been demonstrated that the presence upon a water surface of a suitable monolayer or duplex film may diminish considerably the rate of evaporation[1–3]. That significant retardation of evaporation is not obtained under natural conditions is indicated by the lack of application of the techniques on a larger scale.

It has been stated[4] that the spreading of monolayers does not provide a practicable technique for restricting natural evaporation, because the resistance to transport of vapour provided by the film usually is small compared with the resistance offered by the non-turbulent layer of air above the water surface. It should be noted, however, that the alternative procedure of spreading thick duplex films provides no actual improvement. Fluid duplex films revert to an equilibrium state comprising a monolayer in equilibrium with lenses of oil[4], and in this form offer less resistance to the passage of water vapour than do monolayers of long-chain alcohols. Rigid duplex films are fractured readily by wind and dust.

In the present work, the intrinsic resistances of several monolayers and duplex films have been determined between 20° C. and 60° C., using a technique similar to that adopted by Langmuir and Schaefer[2]. The C_{16}- and C_{18}-aliphatic alcohols provided the least permeable monolayers of those examined, the maximum rate of evaporation through aged films being about six hundred times less than that determined for a clear water surface[1,5] at 25° C. It has been ascertained that monolayers of these substances are affected but slightly by wind and dust.

Except for two periods of a few hours duration, the spreading of monolayers did not reduce significantly the natural rate of evaporation during intervals of the 1952–53 Melbourne summer. On both these occasions, strong desiccating winds were experienced late on dull afternoons. During periods of the 1953 Melbourne winter an average reduction of 25 per cent has been obtained. Marked deviations about this mean value have been observed from day to day, depending on the weather. Simulation in the laboratory of various meteorological conditions produces a parallel variation in the efficiency of monolayers.

The explanation lies in the heat exchange between water and its surroundings. The restriction of evaporation leads to an increase in surface temperature, and accordingly to a compensating increase in the rate of evaporation. Under normal summer conditions, the compensating effect is sufficient to destroy the potential efficacy of a film. In cloudy weather the amount of long-wave radiation reaching the water surface is reduced, and both the surface temperatures and the significance of the compensating effect are decreased also. Accordingly, evaporation is retarded to an extent depending on such conditions. Strong winds also are helpful. It has been both calculated and observed that the absolute rate of evaporation from a film-covered surface decreases as the wind velocity increases, provided the surface receives a flux of radiant energy corresponding to that available near noon on cloudless summer days.

It is apparent that the spreading of surface films cannot significantly reduce the natural rate of evaporation during summer unless some method of restricting the absorption of (particularly long-wave) radiation is provided also. Appropriate investigations are in progress.

W. W. MANSFIELD

Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne, Australia.
Aug. 25.

[1] Baranaev, M., *J. Phys. Chem. U.S.S.R.*, **9**, 69 (1937).
[2] Langmuir, I., and Schaefer, V. J., *J. Franklin Inst.*, **235**, 119 (1943).
[3] Docking, A. R., Heymann, E., Kerley, L. F., and Mortensen, K. M., *Nature*, **146**, 265 (1940).
[4] Heymann, E., and Yoffe, A., *Trans. Farad. Soc.*, **38**, 408 (1942).
[5] Alty, T., *Nature*, **139**, 374 (1937).

Analytical Separation of the Methyl Esters of the C_{12}–C_{22} Fatty Acids by Vapour-Phase Chromatography

James and Martin[1] separated the fatty acids up to lauric acid by passage through a column of kieselguhr and silicone DC.550/stearic acid at 137° C., and measured each fraction automatically by alkali titration.

Mr. N. H. Ray (Imperial Chemical Industries, Ltd., Alkali Division, Winnington) has applied the method to a variety of the lower-boiling alcohols, esters, ketones and hydrocarbons, using dinonyl phthalate (on 'Celite 545') as static liquid phase, and using catharometers and a high-speed recorder for detecting and measuring each component (private communication).

We have developed the technique of vapour-phase chromatography so that separation and measurement of the C_{12}–C_{22} fatty acid esters is now possible, at 230° C. The chromatographic column consists of a vertical spiral 1 in. in diameter with twelve turns (pitch $\frac{1}{2}$ in.), so that the overall length of the column is about 3 ft.; this is packed with the dry mixture of 'Celite' (Johns Manville Co., Ltd.) and Dow Corning High Vacuum Silicone Grease (equal parts, previously mixed by grinding). At the entrance to, and the exit from, the column are attached two platinum-wire catharometers which are connected in a Wheatstone bridge arrangement so that the difference in resistance can be recorded by a Cambridge high-speed recorder. The column and catharometers are wound with asbestos tape so as to form a single unit, which is then placed in an iron cylinder, wound and lagged so that temperatures up to 300° C. (by adjustment of a 'Variac') can be attained. The

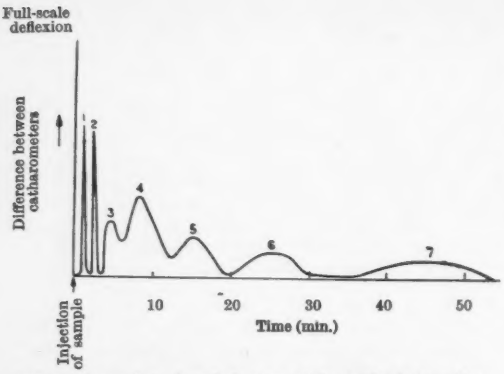


Fig. 1. Separation of methyl esters of C_{12} to C_{22} fatty acids: (1) naphthalene; (2) methyl laurate; (3) methyl myristate; (4) methyl palmitate; (5) methyl stearate; (6) methyl arachidate; (7) methyl behenate

sample (about 0·02 ml.) is introduced from a hypodermic syringe, the needle of which is pushed through a rubber cap at the top of the column; a vacuum pump gives 2 cm. mercury pressure in the exit catharometer, and about 40 cm. mercury in the inlet catharometer, which is fed with nitrogen (8 ml./min.) from a ballast reservoir and gas cylinder.

Under these conditions, the methyl esters of lauric, myristic, palmitic, stearic, arachidic and behenic acids are well separated, the first- and last-named reaching their peaks on the record in 2·5 min. and 45 min. respectively (see Fig. 1). In order to avoid exact measurement of the volume of sample put on to the column, we add previously to the bulk of the sample a known amount of naphthalene, which gives a very sharp band with the peak at 1·0 min.; measurement of the ratios of the peak heights of each ester to naphthalene (the 'internal standard'), and reference to calibration curves gives the amount of each ester on the column, expressed as percentage in the original sample. Oleic acid is not separated from stearic acid, and allowance must be made for this in subsequent calculations (that is, 'apparent stearic acid' figure is corrected according to the iodine value of the original sample). Results of single tests are reproducible to about ± 1 unit at the 10 per cent level, and ± 2–3 units at the 50 per cent level.

This chromatographic method is more rapid and reliable than the ester-fractionation method[2]. One sample examined by the latter method gave a considerable residue (28 per cent), which according to saponification value appeared to be almost pure methyl behenate; chromatography of the original sample showed the presence of large amounts of methyl arachidate (previously 'missed' in the ester-fractionation analysis), in addition to the expected myristate, palmitate and stearate, but only a small amount of methyl behenate was present. Chromatography of the residue from the ester-fractionation test showed that it was largely a complex mixture of unknown components, with only small amounts of the C_{14}–C_{22} fatty acid esters; evidently considerable decomposition had occurred during the lengthy distillation stage.

Small amounts of individual esters can be detected and measured in alleged 'pure' samples by increasing the load on the column; thus a sample (0·05 ml.) of methyl palmitate of melting point 29·5–30·0° C. (lit. 29° C.) contained 2·5 per cent of methyl myristate and 2·5 per cent of methyl stearate.

Each test takes about 40 min. to 'run' and, of course, the column is used repeatedly without re-packing between tests. The method is applicable to samples of the C_{12}–C_{22} fatty acids, after esterification on a 10-gm. scale by the method of ref. 2.

Lauryl, myristyl and cetyl alcohols are also easily separated under these conditions; we propose to investigate the separation of the methyl esters of oleic, linoleic and linolenic acids, and of the components of technical oleyl alcohol.

A detailed account of the investigation on the fatty acid esters and alcohols will be published elsewhere.

F. R. Cropper
A. Heywood

Analytical Laboratories,
Imperial Chemical Industries, Ltd.,
Dyestuffs Division,
Hexagon House,
Blackley, Manchester 9.
Oct. 9.

[1] James, A. T., and Martin, A. J. P., *Biochem. J.*, **50**, 679 (1952); *Analyst*, **77**, 915 (1952).
[2] Hilditch, T. P., "The Chemical Constitution of Natural Fats", 2nd edit., p. 474 *et seq.* (Chapman and Hall, London, 1947).

A Simple Chromatographic Method for the Determination of the C_{10}-C_{20} Saturated Straight-Chain Fatty Acids

In 1951, we described a semimicro chromatographic method for the separation and determination of the C_4–C_{10} volatile fatty acids[1]. In that publication a description was given of the preparation of a silica gel which proved to be highly suitable for this separation. In that method, which is based on the principle of Ramsey and Patterson[2], the fatty acids up to C_{10} are separated on a column of silicic acid, using methanol as the immobile solvent, *iso*octane as the mobile solvent and bromcresol green as the indicator. Since this method is quick and simple and never fails to give excellent results, we have tried to work out an identical method for the determination of the higher saturated fatty acids C_{10}–C_{20}.

Our experiments showed that it is possible to separate these higher acids on the same column used for the C_4–C_{10}-separation; but a very long column is necessary. Moreover, the higher fatty acids proved to be too weak to give a distinct colour change with bromcresol green, which changes colour between *p*H 3·8 and 5·4. We therefore tried indicators changing at higher *p*H intervals. Bromothymol blue, *p*H interval 6·0–7·6, proved to be adequate. On a column tinted with bromothymol blue the colour change with these higher acids is very sensitive; even amounts of about 0·1 mgm. of each acid give yellow bands, which are clearly visible.

With the use of bromothymol blue a second very important advantage was obtained. In preparing a tinted column, enough ammonia must be added to obtain the intermediate colour of the added indicator. Using bromothymol blue, about twenty times as much ammonia is required as in the case for bromcresol green. This relatively large amount of ammonia probably causes salt formation with the acids travelling through and consequently the partition coefficients are considerably altered. With our specially prepared silica-gel[1], tinted with bromothymol blue, neutralized with methanolic ammonia solution, saturated with methanol and using *iso*octane (sat-

urated with a distinct excess of 95 per cent methanol) as the mobile phase, a column length of about 9 cm. is sufficient to obtain a quick and quantitative separation of the straight-chain even-numbered saturated fatty acids from C_{10} to C_{20}. Recoveries of single acids and of the acids in mixtures were between 95 per cent and 105 per cent. Even mixtures containing no more than about 0·5 mgm. of each acid could be analysed with the same accuracy. Our experiments indicate that the range of usefulness can be extended to C_{22} and perhaps to C_{24} acids.

As compared to the reversed-phase chromatography of Boldingh[3] and to the silica method of Ramsey and Patterson[4], our method has the advantage that the position of each acid is visible on the column, that each acid needs only one titration and that the analysis is quick and simple.

A full description of the method will be given elsewhere.

H. J. Nijkamp

Laboratory of Animal Physiology,
Agricultural University College,
Wageningen, The Netherlands.
Oct. 16.

[1] Nijkamp, H. J., *Anal. Chim. Acta*, **5**, 325 (1951).
[2] Ramsey, L. L., and Patterson, W. I., *J. Assoc. Offic. Agric. Chem.*, **31**, 139 (1948).
[3] Boldingh, J., *Rec. Trav. Chim.*, **69**, 247 (1950).
[4] Ramsey, L. L., and Patterson, W. I., *J. Assoc. Agric. Chem.*, **13**, 441 (1943).

The $^{54}Fe(n,p)^{54}Mn$ Reaction

Alper and du Preez[1], working in this laboratory, have reported the production in an atomic pile of manganese-54 from iron-54; but two later studies of pile-irradiated iron[2,3] have not shown the presence of manganese. To clarify the position, we have had the following samples irradiated in the Harwell pile: (1) one 1 gm. sample of sulphur; (2) two samples (10–13 mgm.) of iron enriched in iron-54 and wrapped in cadmium foil 20–30 mils thick; (3) two samples (3 gm. each) of spectroscopically pure iron also shielded with cadmium; (4) two samples of iron (1 gm. each) with no cadmium shielding.

The manganese-54 was separated from the irradiated iron samples in the following way. After dissolving in hydrochloric acid, the iron was oxidized to the ferric form and the acid concentration adjusted to 6·5 *M*. A carrier quantity of manganese was added, and this solution was extracted with ether to remove the bulk of the iron. After evaporation to dryness, manganese was reprecipitated six times, as the dioxide, by potassium bromate oxidation from a 0·25 *M* solution of sulphuric acid[4] to which carrier quantities of iron and cobalt had been added. The precipitation was repeated on the combined filtrates until the residual activity became effectively constant. This activity was due to permanganate formation, the full loss amounting to only 0·6 per cent of the total manganese activity. Activities in the manganese fractions, corrected for decay since removal from the pile, are given in Table 1.

Table 1

Sample	Mass of iron (gm.)	Percentage iron-54	Measured activity (microcuries)	Activity per gm. iron-54 (microcuries)
(2 *a*) Enriched cadmium	0·0130	70·53	0·942	103
(2 *b*) shielded	0·0100	71·39	0·787	110
(3 *a*) Natural iron cadmium	3·005	5·84 [5]	15·0	85·5
(3 *b*) shielded	2·448	5·84	12·5	87·5
(4 *a*) Natural iron	0·989	5·84	5·22	90·6
(4 *b*) unshielded	0·973	5·84	4·91	86·6

Internal agreement is satisfactory, and the differences between the three sets can be explained by self-shielding in the massive iron samples. These results conclusively establish that the activity is produced by fast neutrons on iron-54. We have also obtained a half-life of 324 ± 11 days, and a gamma-ray energy of 825 ± 20 keV. for the separated activity. These agree satisfactorily with the accepted values for manganese-54 of 310 ± 20 days[6] and 835 ± 15 keV.[7].

Fast and thermal neutrons were present in approximately equal numbers, the flux of each being $(1 \pm 0{\cdot}1) \times 10^{13}$ cm.$^{-2}$ sec.$^{-1}$. The samples were irradiated for 120 hr. per week for three weeks. The cross-section for the production of manganese-54 calculated from these figures is 11×10^{-27} cm.^{2}. This is the order of magnitude to be expected for a reaction of this type produced by pile neutrons. From the phosphorus activity produced in the sulphur sample, we get the reasonable ratio of 14 : 1 for the cross-sections of the $^{32}S(n,p)^{32}P$ and $^{54}Fe(n,p)^{54}Mn$ reactions.

Our thanks are due to Mr. J. D. Louw, who determined the isotopic abundance of iron-54 in the enriched samples, to Mr. J. K. Basson for the determination of the gamma-ray energy, and to the Analytical Section of the National Chemical Research Laboratory, for chemical analyses.

This communication is published by permission of the South African Council for Scientific and Industrial Research.

G. H. Stafford
L. H. Stein

S.A. Council for
Scientific and Industrial Research,
Pretoria.
July 21.

[1] Alper, T., and du Preez, L., *Nature*, **165**, 189 (1950).
[2] Freirson, W. J., and Jones, W., *Anal. Chem.*, **23**, 1447 (1951).
[3] Michalowicz, A., and Lederer, M. (private communication).
[4] Kolthoff, H., and Sandell, E. B., *Indust. Eng. Chem.* (*Anal. Ed.*), **1**, 181 (1929).
[5] Bainbridge, K. T., and Nier, A. O., "Relative Isotopic Abundances of the Elements", N.R.C. Preliminary Report No. 9 (December 1950).
[6] Livingood, J. J., and Seaborg, G. T., *Phys. Rev.*, **54**, 391 (1938).
[7] Deutsch, M., and Elliot, L. G., *Phys. Rev.*, **65**, 211 (1944).

Interstitial Atoms in the Layer Structure $ZnMn_3O_7{\cdot}3H_2O$ (Chalcophanite)

Chalcophanite crystallizes in the triclinic system, space group $P\bar{1}$, with $a = 7{\cdot}54$, $b = 7{\cdot}54$, $c = 8{\cdot}22$ A., $\alpha = 117{\cdot}2°$, $\beta = 90°$, $\gamma = 120°$. The crystal structure was determined by Fourier methods of X-ray analysis on a specimen from the U.S. National Museum, Smithsonian Institution.

The structure of this compound consists of sheets of water molecules interleaved between double layers of oxygen atoms co-ordinated to manganese ions. Six out of seven of the octahedral sites between the oxygen sheets are occupied by Mn^{4+} ions, the vacant site at the origin forming a trigonal planar grouping. A similar arrangement of vacant sites is found in

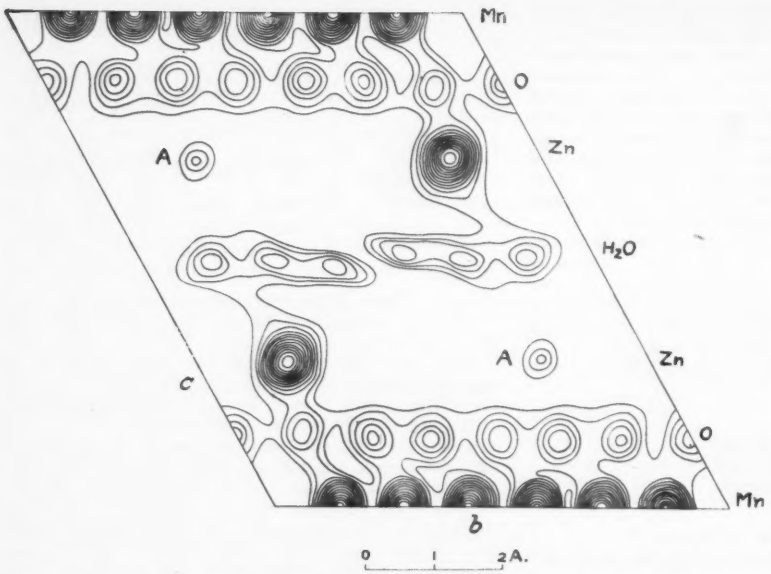


Fig. 1. Electron density of chalcophanite projected on the *b*-axis. Contours at equal but arbitrary intervals. The additional peaks *A* are located in the planes of the zinc ions

the water layer. The MnO_6- and H_2O-layers are close packed, and it is considered that weak hydrogen bonds of the type found for $Zn(BrO_3)_2 6H_2O$ by Yü and Beevers[1] bind the layers together. Zinc, situated above and below the vacancy in the manganese layer, is in one of four possible octahedral sites formed by the packing of these layers. Some idea of the structure is gained from Fig. 1, a projection of the electron density in arbitrary units on the *b*-axis of the crystal.

The density of $3{\cdot}98 \pm 0{\cdot}02$ gm.cm.$^{-3}$ observed for crystals of chalcophanite was found to be $0{\cdot}15$ gm.cm.$^{-3}$ higher than the value computed for the above formula, two units of which are packed into the unit cell. From Fig. 1 it is evident, however, that additional scattering material, not removed by subsequent difference Fourier summations, may be identified in the same sheet as the zinc. This minor peak, *A*, situated above a manganese atom, is located in another interstitial site between the layers. The formulæ for this mineral based upon the recorded chemical analyses[2] generally show an excess of manganese or zinc. If it is assumed that Mn^{2+} may be substituted isomorphously for Zn, the composition can be accurately expressed by the formula $(Zn, Mn^{2+})_{1+\delta} (Mn^{4+}_{2-\delta} Mn^{2+}_{\delta}) O_7 3H_2O$. Fractional quantities δ of divalent ions could occupy the new interstitial position when the other octahedral site *B* was completely filled by zinc. By sharing the oxygens already co-ordinated to Mn^{4+}, these ions would cause a redistribution of the manganese valency electrons in this neighbourhood, recorded as additional Mn^{2+} by chemical analysis. Values of $0{\cdot}14$, $0{\cdot}22$ and $0{\cdot}25$ for δ were computed for the analyses of chalcophanite in Dana[2].

Peak *A* has an electron density of 3–4 *e*.A.$^{-2}$. If this is assumed to be Mn^{2+} for purposes of computation, the empirical formula of this specimen will be $ZnMn_{3.2}O_7 3{\cdot}0H_2O$, giving $3{\cdot}95$ gm.cm.$^{-3}$ for the density, which is in good agreement with the observed value.

The atomic parameters of these interstitial ions have been determined. Only one is located in every four or five unit cells, and as there is no diffraction evidence for a larger unit, these are distributed at random. The structure is believed to represent a partial transition of stoichiometric $ZnMn_3O_7 3H_2O$ to that of another phase which appears to have higher symmetry. There is some evidence[3] that several hydrous oxides of zinc and manganese exist as minerals, and it is proposed to examine these in order further to clarify this system.

A more detailed account has been presented elsewhere for publication.

A. D. Wadsley

Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Melbourne.
Aug. 18.

[1] Yü and Beevers, *Z. Krist.*, **95**, 426 (1936).
[2] "Dana's System of Mineralogy", seventh edit., 1, 739 (1944).
[3] Frondel (private communication).

Influence of some Impurities, notably Potassium, upon the Reactivity of Iodine Pentoxide towards Carbon Monoxide

Considerable quantities of highly reactive iodine pentoxide for use in the determination of carbon monoxide have been prepared successfully from iodic acid made by Lamb's chloric acid process[1,2]. Recently, however, batches giving both high and low initial reactivity have shown a considerable falling off in carbon monoxide recovery, although the low blank determinations suggested good stability. It has been demonstrated that this poor performance is associated with the presence of potassium as an impurity in the iodine pentoxide.

The potassium originates from the barium chlorate used in the preparation of the chloric acid. Alkali metals, mainly potassium, have been found in the barium chlorate in quantities ranging from $0{\cdot}5$ to $1{\cdot}5$ per cent expressed as metal. During the manufacture of iodic acid most of the potassium is lost, but sufficient is retained to affect the reactivity of the iodine pentoxide towards carbon monoxide.

When contaminated iodic acid is dissolved in water, the potash reveals itself as a fine crystalline turbidity. Repeated filtration and recrystallization of the iodic acid have not produced iodine pentoxide capable of giving an initial reactivity better than 95–96 per cent, when using 10-gm. quantities. This apparently satisfactory reactivity deteriorated after

Added impurity	Percentage by wt.	Percentage reactivity			Remarks
		1–3 hr. after dehydration	24 hr. after dehydration	48 hr. after dehydration	
None		96–100	96–100	96–100	An aqueous solution of pure iodic acid to which the solid impurity had been added was evaporated to moist crystals. These were dried in a desiccator and graded 14–25 B.S.
'Analar' potassium iodate	0·5	38			
'Analar' potassium periodate	0·5	36	16		
Potassium iodate	0·5 max.	95	66		Prepared *in situ* by adding 'Analar' potassium chlorate to 25 per cent chloric acid made from triple recrystallized barium chlorate. Iodic acid prepared from this material by the method described (ref. 2).
Potassium iodate	Considerably less than 0·5	94	94	85	Freshly made solid potassium iodate added to a 25 per cent aqueous solution of the same batch of iodic acid from which the potassium iodate was prepared. Allowed to stand 24 hr. with occasional stirring, then filtered, recrystallized and graded.
Sodium paraperiodate	0·5	86	86	90	Freshly prepared material added to an aqueous solution of pure iodic acid, then treated as for 'Analar' potassium iodate and periodate above.
Sodium iodate	0·5	94	94	95	
Barium iodate	1·0	96	96	96	

a short time. Iodine pentoxide which will maintain a high and constant reactivity has only been obtained by removing the potassium impurity by double or triple recrystallization of the barium chlorate.

A limited series of experiments has been made on the reactivity of iodine pentoxide prepared from pure iodic acid to which various contaminants were added. The method of introduction of the impurities and the effects obtained are shown in the accompanying table.

It will be seen that the presence of either 'Analar' potassium iodate or potassium periodate in the iodine pentoxide resulted in a very low initial reactivity. Freshly prepared potassium iodate introduced by either of the methods shown in the table gives an iodine pentoxide with high initial reactivity which deteriorates gradually.

Sodium and barium iodates seem to have little influence on the reactivity of iodine pentoxide, but sodium paraperiodate appears to give an initial short-term effect. The high reactivity with sodium and barium iodates as impurities was maintained over several weeks. Blank runs were carried out between each reactivity determination, and in all cases low values not exceeding 0·3 p.p.m. of carbon monoxide equivalent were obtained. It is therefore evident that low blanks are no guide to the reactivity of iodine pentoxide.

To summarize, it is evident that iodine pentoxide intended for use in carbon monoxide determinations must be as free as possible from potassium. It must be re-emphasized that low blank determinations do not guarantee that the iodine pentoxide is highly reactive towards carbon monoxide, and therefore frequent reactivity checks should be made. Time has not allowed sufficient work to be carried out for any theoretical conclusions to be drawn.

Our thanks are due to the National Coal Board for permission to publish this communication.

E. G. Adams
N. T. Simmons

Scientific Department,
No. 5 Area,
South-Western Division,
National Coal Board,
Ystrad Mynach,
Hengoed, Glam.
Sept. 11.

[1] Lamb, Bray and Geldard, *J. Amer. Chem. Soc.*, **42**, 1636 (1920).
[2] Adams and Simmons, *J. App. Chem.*, 1, Supp. 1, *S.* 20 (1951).

Use of High Contrast in the Photography of Interference Fringes

In the course of some experiments on Poisson's ratio by Cornu's method[1], one of us (B. J. G.) used a photographic method of recording the observed fringes for sodium light. Ilford Thin Film Half Tone Panchromatic plates were used with Johnson's Contrast Developer, and it was noticed that the resulting pattern showed very fine white fringes on a black ground in the negative; comparison with visual observation showed that the recorded fringes were much sharper. It was concluded that this was due to the very high contrast of the photographic process used, and it appeared desirable to make a fuller investigation of this phenomenon. The use of high

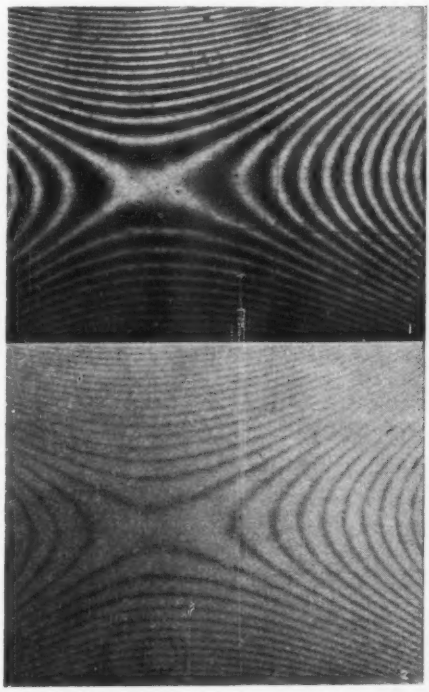


Fig. 1. Exposure of 30 sec. at an aperture of *f*/64
Fig. 2. Exposure of 160 sec. at an aperture of *f*/64

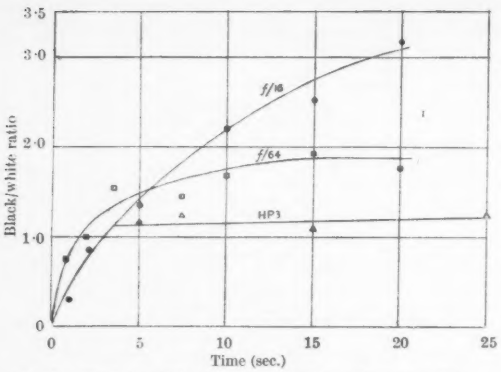


Fig. 3. Black to white ratio as a function of exposure-time

contrast is well known in the photography of subjects of low intrinsic contrast; but the possibility that variation of exposure would produce markedly different negatives seems to be little known and certainly is not widely used.

A series of plates was exposed at the same aperture but for different periods of time, and the plates were given identical treatment during development and fixing. In Figs. 1 and 2, prints are shown of two such plates, one of which had just over five times the exposure of the other; and it will be seen that in the positive print the black fringes become much sharper with the increase in exposure. In order to express the results in a quantitative manner, the ratio of the width of adjacent black and white fringes in the negative was measured, and Fig. 3 is a plot of the black/white ratio against the exposure time. Curves are given for apertures of *f*/16 and *f*/64 of the camera lens, but the exposure times for *f*/64 have been divided by 16 to facilitate comparison. In the same figure a few results obtained for an Ilford *HP*3 plate and the same processing conditions are also given.

It will be seen that the sharpness of the fringes using *HP*3 is practically independent of the exposure, but that the high-contrast system shows a marked change in the fringe-width with exposure. In the negative, a short exposure produces a narrow black fringe on a white background, and a long exposure produces a narrow white fringe on a black ground. (Figs. 1 and 2 show the same effect but are reversed because they are positive prints.) It would have been expected that the curves for *f*/64 and *f*/16 would have been identical after the *f*/64 exposure times had been reduced by a factor of 16; it will be seen from Fig. 3 that this is not the case.

By the choice of a suitable exposure, it is possible to produce very narrow white fringes on a black ground in the negative, and it is much easier to make measurements on such fringes than on the rather diffuse fringes normally obtained. It should also be possible to develop the use of high contrast to such an extent that approximate intensity measurements can be made; this should be useful in spectroscopic work where the expense of a spectrophotometer is not justified.

J. M. Hough
B. J. Goldsmith

Physics Department,
University College,
Hull. July 22.

[1] For example, see Champion and Davy, "Properties of Matter", 72 (London).

Dielectric Properties of Nitrocellulose - Water Gels

The influence of interphasial polarization processes on the dielectric behaviour of aqueous dispersions has been frequently discussed. In earlier communications[1,2], I directed attention to a striking effect of such a process, consisting of an extremely pronounced and broad dispersion region in the low-frequency zone, characterized by a rise in permittivity of the order of 100,000 under maximal conditions. The exact nature of this process has not yet been established. It was thought that the sorbed water might exhibit co-operative orientation, although this remains questionable in the absence of theoretical support. While this work was mainly on coarser systems, it was pointed out that the effect is an important factor in the dispersion found in systems of colloidal and macromolecular structure[3], a particular study[2] being made of gelatin gels in support of this view. This work has now been extended to nitrocellulose gels, in which we have found a strongly developed low-frequency dispersion region, presumably of this same nature. The gels were measured in the form of membranes placed in aqueous solution, a procedure which has certain distinct experimental advantages.

The membranes were prepared from solutions of commercial nitrocellulose in 3/1 to 1/1 ether–alcohol, the porosity being regulated in the usual manner by allowing more or less of the solvent to evaporate under controlled conditions before the membrane was placed in water. The measurements were made by clamping the membrane between the halves of a split conductivity cell and balancing in a calibrated resistance-capacitance bridge, the results given being those obtained after the membrane had come into equilibrium with the bathing solution. Since the (platinized) electrodes did not touch the membrane, the polarization at their surfaces could be taken into account by making measurements on the cell without the membrane. Electrolytic polarization occurred also at the external surfaces of the low-porosity membranes, but its effect was always negligible in the frequency-range studied. The dielectric loss factor tan δ was calculated after subtracting the D.C. conductivity (R_0^{-1} ohm^{-1} cm.$^{-1}$), which could

Fig. 1

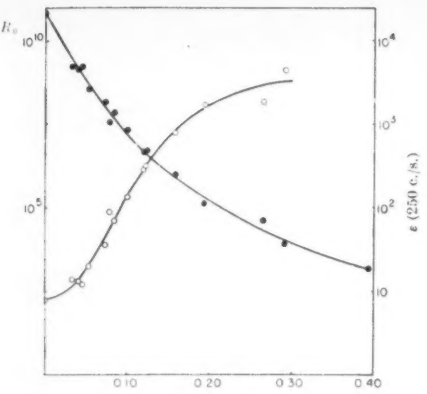


Fig. 2

be defined experimentally, provided voltage and time of observation were kept sufficiently low to prevent secondary changes in the membrane. The water content is given in grams water/c.c. of humid membrane[4] and was defined by drying at 85° C. in vacuum.

Typical results are recorded in the accompanying graphs, obtained on membranes prepared from Baker's U.S.P. collodion, measured in 1 per cent sodium chloride at 21·4° C. Well-dried membranes, of density 1·66–1·67, measured immediately after being placed in the cell, had a permittivity between 7 and 8, showed only weak dispersion and had a power factor of 0·02–0·03. The reliability of the frequency curves, particularly as affected by possible macroscopic heterogeneity of the membranes, was tested by reproducibility studies using substantial variations in the preparatory procedures.

The dielectric behaviour of the nitrocellulose gels is very similar to that of gelatin[2]. The dispersion is pronounced only when the water content is fairly high, the porosity curve (Fig. 2) having the same characteristic form in the two cases, determined by the small effect of the first firmly bound water. The dispersion reaches a maximum around 0·35 gm. water/c.c., at which point the permittivity is of the order of 5,000 at 250 c./s. The average pore radius of a gel of this porosity may be set[5] at 25 A., which may be taken as a rough measure of the thickness of the dielectrically effective surface water-layer. When the porosity is increased beyond this point, the dispersion becomes less pronounced owing to the decrease in internal surface area.

Since the permittivity apparently tends toward constancy at low frequency, the complete dispersion curves may be asymmetrical *S*-curves, which become broader and move toward higher frequencies as the porosity increases. Correspondingly, the power factor curves are, so far as the matter could be tested, characterized by single peaks—at the points of maximal slope of the permittivity curves—which become lower and broader as the porosity increases.

As in the coarser systems, nature and concentration of salt in the bathing solution had no appreciable influence on the dielectric properties, except when the concentration was very low, in which case the permittivity did show a noticeable decrease. This could be due, however, to a change in the distribution of (measuring) field inside the membrane.

This work was supported in part by a contract with the U.S. Office of Naval Research.

Hugo Fricke
Walter B. James Laboratory for Biophysics,
Biological Laboratory,
Cold Spring Harbor, New York.
Aug. 18.

[1] Fricke, H., and Curtis, H. J., *J. Phys. Coll. Chem.*, **41**, 729 (1937).
[2] Fricke, H., and Parker, E., *J. Phys. Coll. Chem.*, **44**, 221 (1940).
[3] Errera, J., *J. Phys. et le Rad.*, **4**, 225 (1923). Murphy, E. J., and Lowry, H. H., *J. Phys. Coll. Chem.*, **34**, 598 (1930). Fricke, R., and Havestadt, L., *Z. inorg. Chem.*, **188**, 357 (1930); **196**, 120 (1931). Fricke, R., *Koll. Z.*, **56**, 166 (1931). Haller, W., *Koll. Z.*, **56**, 170 (1931). Nanty, N., and Valet, M., *C.R. Acad. Sci., Paris*, **194**, 883 (1932). Tausz, J., and Rumm, H., *Koll. Beih.*, **39**, 58 (1933). Kruyt, H. R., and Kunst, H., *Koll. Z.*, **91**, 1 (1940). Mizuno, S., Toshima, S., and Shiratori, H., *J. Electrochem. Soc., Japan*, **18**, 301 (1950).
[4] Weech, A. A., and Michaelis, L., *J. Gen. Physiol.*, **12**, 221 (1928–29).
[5] Bjerrum, N., and Manegold, E., *Koll. Z.*, **43**, 5 (1927). Hitchcock, D. I., *J. Gen. Physiol.*, **9**, 755 (1925–26).

Budding of Erythrocytes in the South African Clawed Toad (*Xenopus laevis*) after Splenectomy

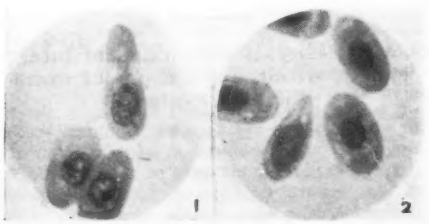
Budding of erythrocytes giving rise to non-nucleated erythroplastids in the peripheral blood was observed by Emmel[1] in ten out of eleven species of urodeles. One species, *Batrachoseps attenuatus*, has approximately 95 per cent non-nucleated erythrocytes[1,2]. Budding in the Anura is less well substantiated. Jordan and Spiedel[3] described stages in the extrusion of the nucleus of erythrocytes of the bullfrog, *Rana catesbiana*.

In *Xenopus laevis*, no erythroplastids could be found either before or after splenectomy. However, after splenectomy, smears of peripheral blood showed nucleated erythrocytes which appeared to be budding (Fig. 1). Such cells were never seen in the peripheral blood or in liver or spleen smears from normal frogs.

These budding cells were to be seen in wet preparations of freshly drawn blood, and are therefore to be distinguished from the fragmentation of nucleated erythrocytes into plastids on standing of wet preparations, as shown by Dawson[4]. Standing of wet smears did not increase the number of budding cells of *Xenopus*, nor were any budding cells seen to complete the separation between the mother cell and the erythroplastid.

The budding cells have larger, more hyperchromatic nuclei than normal mature erythrocytes. Some erythrocytes which were not budding had similar large nuclei, and granularity of the cytoplasm at one pole (Fig. 2).

The significance of budding is difficult to assess. There is little doubt that the budding cells are not artefacts. Because of its large nucleus, one might regard the budding type of cell as juvenile. It might



(×1,200)

be that budding is confined to the spleen, and that resulting erythroplastids are rapidly destroyed in the Anura, but persist in *Batrachoseps* and to a lesser degree in other urodeles.

Marcus Jacobson

Department of Physiology,
University of Cape Town,
South Africa.
Aug. 8.

[1] Emmel, V. E., *Amer. J. Anat.*, **33**, 347 (1924).
[2] Duran-Jorda, F., *Acta med. Scand.*, **40**, 183 (1951).
[3] Jordan, H. E., and Spiedel, C. C., *Amer. J. Anat.*, **32**, 155 (1923).
[4] Dawson, A. B., *Amer. J. Anat.*, **42**, 139 (1928).

Hatching the Contents of Cysts of *Heterodera rostochiensis* with Alternating Temperature Conditions

It is well known that the larvæ of the potato root eelworm, *H. rostochiensis*, are stimulated to emerge from the eggs contained in the cysts by a secretion from the roots of growing potato plants. This root diffusate can be collected and used in the laboratory. Anhydrotetronic acid is also an effective stimulant.

It has been found that an alternation of a high with a low temperature during the hatching of *H. rostochiensis*, with either root diffusate or anhydrotetronic acid, leads to a significant increase in the number of larvæ emerging from a batch of cysts.

Experiments have been conducted in which weekly counts have been made to observe the effect of hatching the cyst contents when: (*a*) a temperature of 25° C. is constantly maintained; (*b*) the temperature is lowered from 25° to 15° C. for 5 hr. twice a week; (*c*) the temperature is lowered from 25° to 15° C. for 5 hr. five times a week.

The results shown below were obtained from several experiments with potato root diffusate.

Number of Larvæ emerging from Batches of One Hundred Cysts (Mean of Four Replicates) after Twelve Weeks Treatment

Exp. No.		Constant temperature	Alternating temperature Twice a week	Alternating temperature Five times a week
1	Non-vintage cysts*	5,739	11,157	13,201
2	Non-vintage cysts	6,222	8,355	11,118
3	Vintage cysts	11,370	17,530	26,819
4	Vintage cysts	13,126	18,421	26,324

* Vintage cysts are cysts of a known age.

A hatching treatment which includes an alternation of temperature probably offers conditions more nearly approximating to those in the soil than one in which the temperature is kept constant, and may help to obtain a complete hatch of larvæ from eelworm cysts.

Daphne D. Bishop

Imperial College Field Station,
Sunninghill, Berks.

Rate of Activity as a Function of Intertidal Height within Populations of some Littoral Molluscs

The physiological reality and profound ecological significance of the phenomenon of regulation of rate functions towards a constant, in response to maintained temperature differences, within the species in poikilotherms, has been widely recognized in recent times. Much attention has been directed in this connexion to a study of populations spatially separated by a wide range of latitude[1–3] or temporally separated by the annual cycle of seasons[4,5]. Indications of the existence of similar intraspecific differences between high and low members of populations of intertidal invertebrates are reported in the present communication.

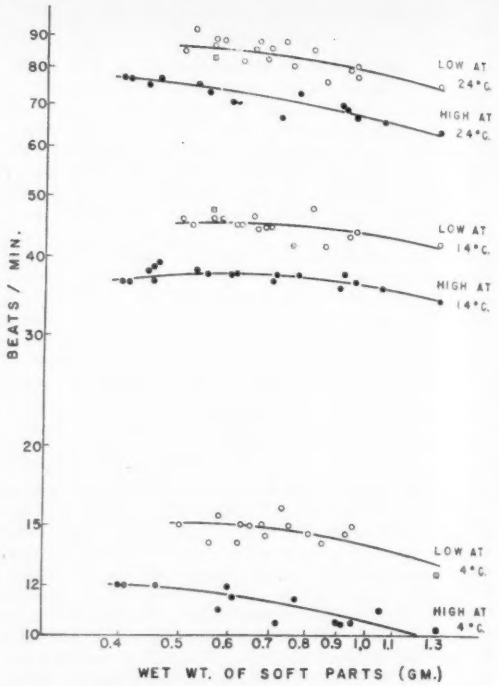


Fig. 1. Relation between frequency of heart-beat and wet weight of soft parts, at various temperatures, in *Acmaea limatula* from Palos Verdes, Calif. Open circles represent low-tide pool individuals from a permanently submerged level; filled circles represent mid-tide individuals from a level (3–4 ft. above zero datum, U.S. Coast and Geodetic Survey Tide Tables), submerged 40–50 per cent of the time. Points are averages of three readings for ten beats each

The lower in the normal intertidal range of distribution limpets of the species *Acmaea scabra* and *A. limatula* are collected, the higher the rate of heart-beat at any given temperature. This is shown, with weight controlled, in Fig. 1. The heart has been exposed by a trephine hole in the shell, after which the rate of beat settles down shortly to a rather uniform value for many days. Counts were made three days after collecting and trephining; the animals were kept in the meantime in standing, aerated sea water at 14° ± 0·5° C., changed daily. Two hours was allowed for equilibration at each temperature. The regime of temperatures and of handling in collecting, operating and counting, while not critical, has been carefully standardized for the data on *A. limatula*. A few counts were discarded because of excessive locomotor activity or irregularity of heart-beat.

Mussels (*Mytilus californianus*) show the same relationships (Fig. 2) when rate of propulsion of water is measured by photoelectric estimation of clearing rate of dilute colloidal graphite suspensions[3,6]. Each point on the graph represents the average of three measurements for each individual in a group

of 5–15 mussels. Measurements were made within a week of collection, the animals being kept in standing, aerated sea water at 15° ± 1° C. (intertidal samples) or 11° ± 1° C. (deep sample).

This phenomenon is comparable to the differences found between populations of *Mytilus* of the same species from different latitudes[3]. The lower intertidal individuals act like those from higher latitudes, or in other words, appear to be cold-adapted relative to those from higher tidal levels only a few feet away. The same is true of the 'deep' mussels from subtidal populations. These and low-tide individuals, like those from high latitudes, furthermore show less weight-dependence, allowing them to grow larger. Whether the higher specimens are, in fact, exposed to higher average temperatures, integrated, for example, in degree-hours or in some other way, is as yet unknown.

The tendency of Q_{10} to vary systematically with size and habitat temperature in *Mytilus* and other species is discussed elsewhere[7].

Although differences between the samples of different origin persist in the laboratory for weeks at a given temperature, it is of considerable interest that preliminary transplantation experiments in the field by one of us (E. S.) using *Acmaea limatula* have resulted in reversal in both directions within four weeks. This is true not only of heart-rate but also of the condition of gonads and of shell-weight relative to weight of soft parts, both of which features are found to vary systematically with intertidal level (for details in *Mytilus*, see Rao[8]).

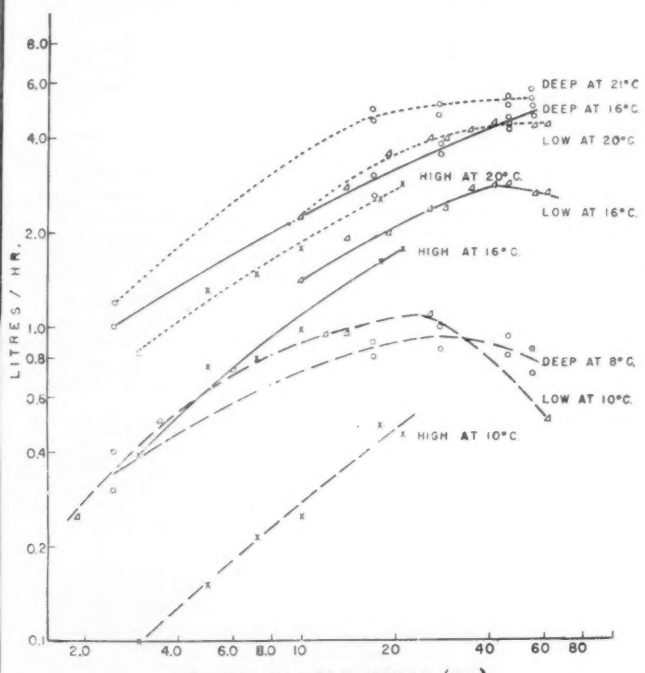


Fig. 2. Rate of water propulsion in three populations of *Mytilus californianus*, at three temperatures. Open circles from 'deep' water (30 ft.; off Pt. Vicente, Calif.); triangles, low intertidal (1–2 ft. above zero datum); crosses, middle intertidal level (4 ft. above zero datum; from pilings at Santa Monica, Calif.). For the low intertidal the data from Rao (ref. 3) have also been used. The degree of variation is indicated by the pairs of points for the deep mussels

A more complete report will be published elsewhere. Acknowledgments are due to Dr. Theodore H. Bullock for his interest and guidance, and for aid from a grant from the National Institutes of Health, U.S. Public Health Service.

Earl Segal
K. Pampapathi Rao
Thomas W. James

Departments of Zoology,
University of California,
Los Angeles and Berkeley.
Aug. 10.

[1] Bullock, T. H., "To What Degree are Aquatic Cold Bloods Independent of Temperature?", unpublished paper read at symposium on Factors in Distribution of Intertidal Organisms, Western Society of Naturalists Meeting, Claremont, California (1951).
[2] Scholander, P. F., Flagg, W., Walters, V., and Irving, L., *Physiol. Zool.*, **26**, 67 (1953).
[3] Rao, K. P., *Biol. Bull.*, **104**, 171 (1953).
[4] Doudoroff, P., *Biol. Bull.*, **88**, 194 (1945).
[5] Edwards, G. A., and Irving, L. J., *J. Cell. and Comp. Physiol.*, **21**, 169 (1943).
[6] Jørgensen, C. B., *Acta Physiol. Scand.*, **5**, 297 (1943).
[7] Rao, K. P., and Bullock, T. H. (in preparation).
[8] Rao, K. P., *Experientia* (in the press).

Feeding Mechanism of an Ephemeropteran Nymph

A study of the wood-boring and tubicolous mayfly nymph, *Povilla adusta* Navás. (Ephemeroptera, Polymitarcidae), common in the lakes of East Africa, has shown that it is remarkable in two respects.

Unlike any other Ephemeropteran nymph described, it lives in a tube lined with silk which it secretes[1]. It is also unusual in having a complex setal filter-feeding habit. A few other insects having the filter-feeding habit use setæ for the purpose; for example, larvæ of *Simulium* (Diptera), nymphs of *Oligoplectrum maculatum* Fourcroy[2] and *Brachycentrus nigrosoma* Banks[3] (Trichoptera) and *Isonychia* spp.[4] (= *Chirotonetes*) (Ephemeroptera). But all these forms are rheophilous and rely on the flow of water in which they live to bring their food. The nymph of *Povilla*, on the other hand, lives in the comparatively still water at the edges of lakes, inhabiting burrows in wood and the roots of waterplants and holes in laterite (personal communication from R. H. Lowe), and creates its own feeding current by movements of the gills.

The principal modifications associated with the feeding habits affect the mandibles and the forelegs. The mandible is unusual in possessing on the outer side a brush of filtering setæ, consisting of a *U*-shaped row of large alveoli from each of which springs a long pinnate seta. The forelegs bear similar brushes on the femora and tibiæ. Each femur bears anteroventrally a narrow oval ring of alveoli bearing the setæ, whereas the tibiæ each bear two brushes, one anterodorsal and the other anteroventral.

The setæ comprising all these brushes point somewhat forwards and practically occlude the lumen of the tube, the dorsal space being filled by a transverse row of pinnate setæ on the frons.

The feeding of the nymphs was observed by encouraging them to enter short lengths of glass-tubing in Petri dishes full of water placed under a binocular microscope. When entering a new tube the nymphs usually spin a silken lining to the tube. The silk is produced from the oral region and drawn out by flicking movements of one of the forelegs. The presence of this lining in the natural burrows of the nymphs was first noted by Arndt[1], but further work remains to be done on this aspect of the insect's biology. In glass tubes and possibly also in burrows in wood, this lining of silk enables the animal to hold itself firmly in position by means of the short stout setæ on the outer sides of the hind femora, which are pressed against the walls of the tube.

During feeding, the gills, which are borne in pairs on the first seven abdominal segments, beat rhythmically for a few seconds at frequent intervals, producing an intermittent current of water from the anterior end. Any floating organisms or pieces of debris which are large enough are caught on one or other of the filtering brushes, from which they are removed by the palps. Food is transferred from the brushes to the mouth by two distinct series of movements. The transfer of particles from the brushes to the palps is accomplished by simultaneous wide sweeping movements: (1) by the maxillary palp of one side, removing food from the mandibular brush of that side; (2) by the maxillary and labial palps of the opposite side, collecting food from the tibial and femoral brushes respectively; this action is accompanied by an inward flick of the leg which brings the brushes within reach of the palps.

These movements alternate from side to side and are separated by the second type of movement of the palps which brings the food to the mouth. Here the maxillary palps move in a transverse plane and push food towards the apices of the labial palps. The latter, swinging up and down on the basal joint, push the particles of food backwards and upwards to the mouth. By these means food is collected from either side of the body according to the following scheme: (1) mandibular brush to maxillary palp; (2) palps to mouth; (3) leg brushes to maxillary and labial palps; (4) palps to mouth.

The only pinnate setæ which are not swept by the palps are those on the frons, and these appear to be neglected. Possibly they serve to deflect the water current towards the other more ventral filtering brushes.

Further details of this work will be published elsewhere, together with results of studies of other aspects of the biology of this species. I wish to thank Prof. L. C. Beadle for his encouragement and advice, and also Mr. D. E. Kimmins for identifying the species for me.

R. Hartland-Rowe

Biology Department,
University College of East Africa,
Kampala, Uganda.
Aug. 26.

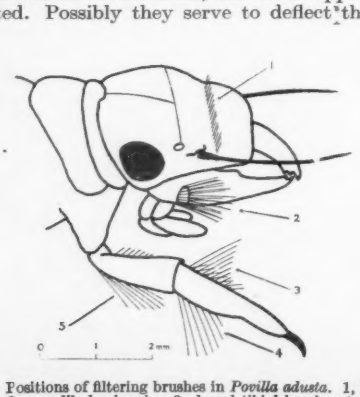


Fig. 1. Positions of filtering brushes in *Povilla adusta*. 1, Frontal brush; 2, mandibular brush; 3, dorsal tibial brush; 4, ventral tibial brush; 5, femoral brush

[1] Arndt, W., *Explor. Parc Albert, Miss. Damas.*, **2**, 5 (1938).
[2] Nielsen, A., *Biol. Medd. Kbh.*, **19**, (2), 70 (1943).
[3] Needham, J. G., and Lloyd, J. T., "The Life of Inland Waters" (Ithaca, N.Y., Comstock, 1916).
[4] Needham, J. G., Traver, J. R., and Yin-Chi Hsu, "The Biology of Mayflies" (Ithaca, N.Y., Comstock, 1935).

Chemical Examination of the Piltdown Implements

In the report[1] on the main results of our re-examination of the Piltdown material, we gave reasons for regarding the chromate staining of the *mandible* as indicating a deliberate attempt to match a modern bone with the mineralized cranial fragments. The actual composition of this bone (3·9 per cent nitrogen, less than 0·03 per cent fluorine) suffices to prove its modernity; but the chromate staining, combined with the artificially abraded appearance of the molars, indicates that it is not only modern but also fraudulent.

In case there is any lingering doubt that the Piltdown finds are in part fraudulent, we think that one other fact now brought to light should be published immediately. Suspecting that some of the so-called implements[2] reported from the site might have been 'doctored', we asked Mr. E. T. Hall, of the Clarendon Laboratory, Oxford, to test the composition of their surface stains by means of his X-ray spectrographic method of analysis. He has reported to us that the stains on these flints are entirely ferruginous, with one notable exception. The triangular flint (Reg. No. E.606) recovered *in situ* from the layer immediately overlying the skull horizon[3] is chromate stained. When this stain is removed in acid the flint appears greyish-white. It is indistinguishable from a mechanically broken piece of flint such as one might encounter on the surface of any ploughed field in 'Chalk-land'.

Whereas a bone might have been dipped in a solution of potassium dichromate with the sole purpose of trying to harden it, a flint would only have been treated in that way by a forger requiring it to be of a certain colour.

K. P. Oakley

Department of Geology,
British Museum (Nat. Hist.),
London, S.W.7.

J. S. Weiner

Department of Anatomy,
University of Oxford.
Nov. 24.

[1] Weiner, J. S., Oakley, K. P., and Clark, W. E. Le Gros, *Bull. Brit. Mus. (Nat. Hist.)*, Geol. Ser., **2**, No. 3 (1953).
[2] Doubts about their genuineness were expressed in 1949 in a handbook of the British Museum (Nat. Hist.), "Man the Tool-Maker", 1st edit., pp. 69–70.
[3] Dawson, C., and Woodward, A. S., *Quart. J. Geol. Soc. Lond.*, **69**, 122, footnote 1, pl. xvi, fig. 2 (1913).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 14

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Will Transistors Oust Receiving Valves?"

ROYAL SOCIETY OF MEDICINE, ODONTOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Dr. K. A. Bisset: "The Bacterial Flora of the Human Mouth".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Tom Harrison: "Inside Borneo".

Tuesday, December 15

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (joint meeting with the EAST INDIA ASSOCIATION, at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. Wilfred Novce: "Some Scientific and Technical Aspects of the Everest Expedition" (Thomas Holland Memorial Lecture).

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. K. MacFadyen: "Electrical Breakdown in Liquids".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. C. Eltenton: "Instruments for Quality Control".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, London, W.C.2), at 7 p.m.—Mr. R. E. James: "A High-Voltage Laboratory".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. D. L. Ellis: "Jet-Driven High-Speed Wind Tunnels".

Wednesday, December 16

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. Laurence Pritchard: "The Work of the Wright Brothers for Aviation".

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the ROYAL ASTRONOMICAL SOCIETY, at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Discussion on "Stellar Scintillation". Opening speakers: Dr. H. E. Butler, Dr. M. A. Ellison, Dr. E. C. S. Megaw and Dr. J. Van Isacker (Belgium).*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Hermann Lehmann: "The Distribution of the Sickle Cell Trait in Africans and Indian Aboriginals".*

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. R. W. G. Wyckoff: "The Electron Microscopy of Viruses".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (in the University Staff House, Burlington Street, Manchester), at 7.15 p.m.—Dr. Redcliffe N. Salaman, F.R.S.: "The Social Impact of the Potato on the New and Old Worlds".

Wednesday, December 16—Thursday, December 17

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 10 a.m. each day—Conference on "The North Sea Floods".

Thursday, December 17

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. H. M. McNaughton: "The Origin of the Northern Rhodesia Copper Deposits"; Mr. W. G. Garlick: "Reflexions on Prospecting and Ore Genesis in Northern Rhodesia".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. P. J. Hilton: "Homological Algebra".

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Dr. E. C. Cherry: "Information Theory and Television".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, December 18

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Papers on "Developments in Radio Aids to Surface Navigation".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. G. Conway: "Technical Features of the New British Standard System of Limits and Fits"; Mr. G. J. Pearmain: "The Practical Application of the New British Standard System of Limits and Fits".

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. W. G. King: "Magnetic Particle and Surface Penetrant Methods of Flaw Detection".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Prof. D. H. R. Barton: "Steroidal Alkaloids".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT CHEMIST (with university degree or equivalent and good experience in general analytical work)—The Chief Engineer, Middlesex County Council, Main Drainage Department, Mogden Works, Isleworth, Middlesex, quoting M.755T (December 19).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree in botany or other suitable qualification) AT THE WELSH PLANT BREEDING STATION, for work in grass and clover breeding—The Registrar, University College of Wales, Aberystwyth (December 19).

LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, Wye College, Wye, Ashford, Kent (December 19).

SENIOR LECTURER (with honours degree and good experience in technical teaching) IN MATHEMATICS—The Principal, County Technical College, Stoke Park, Guildford (December 19).

EXPERIMENTAL or ASSISTANT EXPERIMENTAL OFFICER (with at least H.S.C. (science) or equivalent) at the Atomic Energy Research Establishment, Harwell, for work on problems associated with fundamental physical and metallurgical studies related to the design of fuel for nuclear reactors—The Establishment Officer, A.E.R.E., Harwell, Berkshire, quoting 2/103/19 (December 21).

PRINCIPAL INVESTIGATIONAL CHEMIST (university graduate or professionally qualified, and interested in the development of analytical methods and investigation of problems with a chemical background, related to steam and electricity generation), with the British Electricity Authority, London Division—Divisional Secretary, B.E.A., London Division, Generation House, Great Portland Street, London, W.1 (December 22).

SCIENCE LECTURER IN THE SOUTH AUSTRALIAN SCHOOL OF MINES AND INDUSTRIES, North Terrace, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (December 24).

RESEARCH ASSISTANT IN VIRUS DISEASES for research involving tissue culture of viruses—The Secretary of the University Court, The University, Glasgow, W.2 (December 26).

ASSISTANT LECTURER IN CHEMICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (December 31).

ELECTRICAL or MECHANICAL ENGINEER (with first- or second-class honours degree or equivalent in electrical or mechanical engineering, and at least three years postgraduate research experience), at a Ministry of Supply Design Establishment, near Sevenoaks, Kent, to lead section engaged in design and development of electrical and mechanical components and of complete control schemes for armament equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D476/53A (January 1).

LECTURER IN BACTERIOLOGY AND VIRUS DISEASES—The Registrar, The University, Sheffield (January 2).

RESEARCH OFFICER (with an honours degree in science with botany and chemistry as major subjects, or in agricultural science or equivalent qualifications), in the Commonwealth Scientific and Industrial Research Organization, Division of Plant Industry, Plants and Soils Laboratory, Brisbane, to undertake studies on the factors limiting legume establishment in sub-tropical areas and southern Queensland—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 146/34 (January 2).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with good first- or second-class honours degree in chemistry, and preferably with special knowledge of, and experience in, one or more of the following fields: essential oils, perfumery materials, gums and resins, spices), to undertake laboratory investigations and to supervise the work of junior staff and intelligence work (Ref. F.651/53A); EXPERIMENTAL OFFICERS (2) (with general certificate of education at advanced level in science, and preferably with some postgraduate laboratory or works experience in connexion with either insecticides and/or drugs of vegetable origin or the food canning or drying industries), (Ref. F.652/53A), at the Colonial Products Advisory Bureau (Plant and Animal), London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (January 2).

LECTURERS IN ELECTRICAL ENGINEERING, PHYSICS, BIOLOGICAL SCIENCES and MATHEMATICS; SENIOR LECTURERS and LECTURERS IN INORGANIC CHEMISTRY, MECHANICAL ENGINEERING, METALLURGY (Physical), METALLURGY (Process) and METALLURGY (Mechanical), and a SENIOR LECTURER IN TECHNOLOGY (Chemical and Metallurgical), at the New South Wales University of Technology, Sydney—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2 (January 4).

LECTURER or SENIOR LECTURER (with special interest and experience in agronomy) IN AGRICULTURE, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 9).

CHAIR OF CHEMICAL ENGINEERING in King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (January 18).

LECTURER (graduate in science or technology and with a good knowledge of the theory of structures) IN STRUCTURAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (January 20).

PROFESSOR OF AGRICULTURAL BOTANY and a PROFESSOR OF MATHEMATICS—The Registrar, The University, Reading (January 25).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary, The University, Edinburgh (February 15).

LECTURER IN PURE MATHEMATICS—The Secretary, Queen's University, Belfast (February 15).

LECTURER IN FORESTRY—The Secretary, The University, Aberdeen (February 28).

PLANT PATHOLOGIST (with honours degree in botany, and postgraduate experience in plant pathology, and preferably with experience in tropical plant diseases, especially those of the sugar cane) at the Mauritius Sugar Industry Research Institute—The Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius (March 31).

ASSISTANT DIRECTOR to take charge of a team of mathematicians, physicists and chemists, engaged on a comprehensive scientific study of the physical and chemical properties of rayon and synthetic fibres—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

ASSISTANT PROFESSOR IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Head of the Department of Electrical Engineering, University of British Columbia, Vancouver, or The National Research Council of Canada Representative, Africa House, Kingsway, London, W.C.2.

ENTOMOLOGIST (with a university qualification with entomology as a special subject) at the Tsetse Control Unit of the Veterinary Department, Government of Nigeria, for work on the control and eradication of tsetse fly in relation to Trypanosomiasis of cattle—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.67/14/02.

HONOURS PHYSICIST for research on the friction and lubrication of textile materials—The Director, Shirley Institute, Manchester 20.

LECTURER (with qualifications in agricultural botany, or in botany with bacteriology or zoology) IN THE BIOLOGY DEPARTMENT—The Principal, Seale-Hayne Agricultural College, Newton Abbot, Devon.

PHYSICIST (with a good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee, quoting N.1.

PHYSICISTS (with a good honours degree and some experience or training in research), for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

SCIENTIFIC OFFICER (with at least a good second-class honours degree in entomology, and preferably with some knowledge of mycology), at the Forest Products Research Laboratory, Timber Borer Research Unit, Princes Risborough (but may be required to visit W. Africa), to investigate pinhole borer beetles and associated staining fungi in timbers—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.61/11/01.

SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in mathematics or physics) at an R.A.F. Station near Oxford, for operational research duties in connexion with aerial photography—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.313/53A.

SENIOR LECTURER IN PHARMACOLOGY—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

SOIL SURVEY OFFICERS (with university degree in geography, and preferably with a knowledge of chemistry, and interest in botany and plant geography), in Nigeria, for field work in connexion with a scheme of systematic classification and mapping of soils—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/14/021.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institute of Navigation. Report of the Council for 1952–53. Pp. 10. (London: Institute of Navigation, 1953.) [910

Scottish Home Department. Freshwater and Salmon Fisheries Research. No. 5: Spawning Migration, Reproduction and Young Stages of Loch Trout (*Salmo trutta* L.). By T. A. Stuart. Pp. 40. (Edinburgh: H.M. Stationery Office, 1953.) 7*s.* 6*d.* net. [910

British Rubber Producers' Research Association. Publication No. 181: The Electronic Spectra of Conjugated Hydrocarbons. By W. Moffitt. Pp. 21. Publication No. 182: Some Calculations on the Ethylene Molecule. By W. Moffitt and J. Scanlan. Pp. 23. (London: British Rubber Producers' Research Association, 1953.) [1210

National Institute of Industrial Psychology. Report 9: Women's Attitudes to Repetitive Work. By David Cox, assisted by K. M. Dyce Sharp and D. H. Irvine. Pp. iv+60. 2*s.* 6*d.* Report 10: Two Studies in Supervision: Messrs. Exe and Co. By Elizabeth Livingstone; Supervision in a Cotton Spinning Firm. By John D. Handyside. 2*s.* 6*d.* (London: National Institute of Industrial Psychology, 1953.) [1210

Report of Her Majesty's Civil Service Commissioners for the period 1st April, 1949, to 31st March, 1952. (Being the Eighty-Fifth Report of the Commissioners.) Pp. 61. (London: H.M. Stationery Office, 1953.) 2*s.* net.

General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages, Infectious Diseases, Weather, Population Estimates. Quarter ended 30th June, 1953. Pp. 28. (No. 418.) (London: H.M. Stationery Office, 1953.) 2*s.* net. [1610

Anti-Locust Bulletin 15: The Study of the Numbers of the Red Locust (*Nomadacris septemfasciata* Serville). By Dr. O. W. Richards. Pp. ii+30. (London: Anti-Locust Research Centre, 1953.) [1610

Bulletin of the British Museum (Natural History). Entomology, Vol. 3, No. 2: A Pest of Coconut Palms in Portuguese East Africa. Two New Representatives of the Genus *Hypotrabala* (Lepidoptera: Lasiocampodae) from the Belgian Congo. By W. H. T. Tams. Pp. 67–75+2 plates. (London: British Museum (Natural History).) 4*s.* [1610

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the Year 1951. (With Report of the Geological Survey Board and Report of the Director.) Pp. iii+76. (London: H.M. Stationery Office, 1953.) 2*s.* 6*d.* net. [2010

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 65—Part 2 (No. 10): Frictional Fusion Along a Himalayan Thrust. By J. S. Scott and H. I. Drever. Pp. 121–142+6 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 6*s.* 9*d.* [2010

Other Countries

United States Department of the Interior: Geological Survey. Professional Paper 220: Geology and Geography of the Zion Park Region, Utah and Arizona. By Herbert E. Gregory. Pp. vi+200+5 plates. (1950.) 1.75 dollars. Professional Paper 222: Geology and Paleontology of the Santa Maria District, California. By W. P. Woodring and M. N. Bramlette. Pp. iv+185+23 plates. (1950.) Professional Paper 232: Paleocene Foraminifera of the Gulf Coastal Region of the United States and Adjacent Areas. By Joseph A. Cushman. Pp. iii+75+24 plates. (1951.) 1.75 dollars. (Washington: Government Printing Office.) [910

United States Department of the Interior: Geological Survey. Professional Paper 233-B: Molluscan Fauna of the Morrison Formation. By Teng-Chien Yen. (Shorter Contributions to General Geology, 1950.) Pp. iii+21–51+plates 3–6. (1952.) 65 cents. Professional Paper 239: Scaphitoid cephalopods of the Colorado Group. By W. A. Cobban. Pp. iii+42+21 plates. (1951.) 1.50 dollars. (Washington: Government Printing Office.) [910

Aeromedica Acta. Vol. 1, 1952. (Collected Papers.) Pp. 114. (Soesterberg: National Aeromedical Centre, 1952.) [910

B.A.N.Z. Antarctic Research Expedition 1929–1931. Reports—Series B (Zoology and Botany). Vol. 8, Part 1: Taxonomy, Distribution and Development of the Euphausiacea (Crustacea). By Keith Sheard. Pp. 72. (Adelaide: B.A.N.Z.A.R. Expedition Committee, 1953.) 32*s.* [910

Transvaal Museum, Pretoria. Report for the Year ending 31st March, 1953. Pp. 42+42. (Pretoria: Transvaal Museum, 1953.) [1210

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. A.N.A.R.E. Reports, Series D: Meteorology. Vol. 4: Heard and Macquarie Islands, 1951. Pp. xiv+145. (Melbourne: Antarctic Division, Department of External Affairs, 1953.) [1210

Canada: Department of Mines and Technical Surveys. Mines Branch. The Canadian Mineral Industry—Reviews by the Staff of the Mines Branch. (Publication No. 841.) Pp. xi+170. (Ottawa: Queen's Printer, 1953.) 50 cents. [1210

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1952. Pp. 32+8 plates. (Zomba: Government Printer, 1952.) 4*s.* [1210

Report of the South African Museum for the period ended 31 March, 1953. Pp. 24. (Cape Town: South African Museum, 1953.) [1210

Bulletin of the Astronomical Institutes of the Netherlands. Vol. 12, No. 444: On the Velocity Curve of AI Velorum. By Livio Gratton. Pp. 31–34. Vol. 12, No. 445: Computation of the Elements of the Eclipsing Variable V505 Sagittarii from Photoelectric Observations made by Prof. P. Th. Oosterhoff. By K. K. Kwee. Pp. 35–56. Vol. 12, No. 446: On the Short-period Variable HD 223065. By Th. Walraven. Pp. 57–60. Vol. 12, No. 447: Brightness, Polarization and Electron Density of Streamers in the Solar Corona. By M. Schmidt. Pp. 61–68. (Leiden: Astronomical Institutes of the Netherlands, 1953.) [1210

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien. Band 3, N:r 5. Luminosity Effects and Colour-equivalents as Measured in Short Stellar Spectra. 2: F. G. and K. Stars. By Bengt Westerlund. Pp. 79. (Stockholm: Almqvist and Wiksells Boktryckeri A.B.: London: H. K. Lewis & Co., Ltd., 1953.) 11 Kr. [1210

Canada: Department of Mines and Technical Surveys. Geological Survey of Canada, Bulletin 26: Bedrock Geology of the Seaboard of Labrador between Domino Run and Hopedale, Newfoundland. By E. H. Kranck. Pp. v+45 (5 plates). 50 cents. Geological Survey of Canada, Memoir 270: Weldon Bay Map-Area, Manitoba. By J. Kalliokoski. Pp. vii+80 (4 plates). 75 cents. Geological Survey of Canada, Memoir 271: Batty Lake Map-Area, Manitoba. By D. S. Robertson. Pp. v+55 (3 plates). 75 cents. (Ottawa: Queen's Printer, 1952 and 1953.) [1610

Commonwealth of Australia: Department of External Affairs. Australian National Antarctic Research Expeditions. A.N.A.R.E. Reports, Series B. Vol. 1: Zoology. The Egg-Laying and Incubation Periods of Rockhopper, Macaroni and Gentoo Penguins. By A. M. Gwynn. Pp. ii+29. (Melbourne: Antarctic Division, Department of External Affairs, 1953.) [1610

Canada: Department of Mines and Technical Surveys. Dominion Observatories. Publications of the Dominion Observatory, Ottawa. Vol. 14. Bibliography of Seismology, No. 11: Items 7783–7952. Pp. ii+211–233. (Ottawa: Queen's Printer, 1953.) 25 cents. [1610

Catalogues

Royal Photographic Society of Great Britain. Library Catalogue. Supplement (1950–1952) to Subject Catalogue. Pp. 44. (London: Royal Photographic Society of Great Britain, 1953.)

74704-A Standard-Bicera Spark Control Unit and associated Cylinder Pressure Calibrating Units. Pp. 12. (London: Standard Telephones and Cables, Ltd., 1953.)

Industrial Fluoroscopic Equipment. Pp. 8. (London: Solus-Schall, Ltd., 1953.)

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office